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TO OUR CONTRIBUTORS

SCHOOL SCIENCE invites articles from teachers, acquainting students with the recent developments in science and science methodology. The articles should be addressed to Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110016.

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Science in the Curriculum

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A QUALITY science curriculum needs to be in evidence in the school/class setting. Each person lives in a world of science. The natural environment with its plants and animals reflects subject matter in science. Inventions and technology to improve the lot of each person truly emphasizes the methods and content of science.

To live effectively in society, students individually need to experience the wonders and contributions of science and scientists. A vital program of science instruction should be the lot of each student.

The Use of Experiments

A modern program of elementary school science will have much in the area of experiments that pupils will perform with teacher guidance. This will mean that learners should actually be involved in conducting these experiments whenever possible. Almost all units taught in elementary school science can emphasize experimentation. For example, if pupils are studying a unit on "Magnetism and Electricity", the following objects and items can be placed on a learning center to initiate the unit :

(1) containers which contain shreds of paper, pieces of wood, a piece of plastic, and different kinds of cloth.
(2) nails, paper clips, different size coins, a piece of copper, and other kinds of metals.

Pupils can notice which objects and items on the learning center are attracted and which are not attracted by the use of magnets.

Scientists engage in conducting many experiments. This is a way of gaining new knowledge. It is a way of identifying new problem areas. Once these problem areas have been clearly defined ; information can be gathered to solve these problems. A hypothesis or hypotheses are then developed which pertain to an answer or a solution to the problem. The hypothesis or hypotheses are tentative and not final or fixed. Only through testing can elementary school pupils develop some degree of certainty as to the correctness or accuracy of the hypothesis. Too frequently when science experiments are conducted pupils want to jump to hasty conclusions as to the outcomes. An experiment or experiments are conducted to test a hypothesis or several hypotheses. In the preceding example pertaining to the unit "Magnetism and, Electricity", pupils could hypothesize as to which kinds of objects and items will be attracted by the magnets. This is only a hypothesis and not a fact. The hypothesis, of course, is based on knowledge. Pupils could then test the hypothesis with the actual using of the magnets. Different kinds of magnets should be utilized to test the hypothesis. Hypotheses are substantiated modified, or refuted based on testing. As time goes on, with the further study and thought, new concepts and generalization may be developed pertaining to previously held conclusions.

Very early in the experiences of elementary school pupils, the concept of "experi mental" and "control groups" should be emphasized. Pupils on the kindergarten level, for example, may be studying a unit on "Plants in Our Community". The questions may arise as to what plants need in order to grow well. On a learning center, two potted plants can be placed. It is important to have these plants as alike as possible in terms of quality. The soil should be as comparable as possible for the two potted plants. The amount of moisture that each potted plant is to receive should be held constant also. In other words, both potted plants should receive the same treatment except for one variable which will be tested. This variable will be that one of these potted plants has a cardboard box placed over it. This plant will represent the experimental group whereas the other potted plant will be the control group. Pupils can then test their hypothesis as to what will happen to the plant in the experimental group if it receives no sunshine. The plant in the experimental group can be compared with the plant in the control group at selected intervals. Experiments such as these should be conducted using a variety of kinds of plants. In each case there should be an experimental group as well as a control group. If the outcomes are always the same in this experiment, pupils can achieve accurate generalizations.

In the unit previously mentioned pertaining to "Plants in Our Community", other variables can be tested also as to what plants need in order to grow. Let us again assume for purposes of discussion that the two potted plants are as similar as possible in terms of quality. They receive the same amount of sunshine due to their location. The soil of these potted plants is similar. The one variable that will now be tested will pertain to the amount of moisture that one plant will receive as compared to the other plant. Desert plants would not be involved in this experiment. One of the potted plants will receive no moisture while the other receives a proper amount. Pupils can observe what happens at different intervals when the experiment is being conducted. The plant receiving no moisture for a period of time would be in the experimental group whereas the plant which is receiving the normal treatment is in the control group. Again, pupils should have ample opportunities to observe what actually happens when the one variable is tested. Another variable that could be tested in the experiment would be the soil that is used in the potted plant. All other variables would remain the same. Pupils could use three kinds of soil ; sandy soil, clay and loam. Thus, with several experiments such as these, pupils could generalize as to which kind of soil is most beneficial to plants.

Pupils must have opportunities to identify problems and questions ; secondly, information or data needs to be gathered ; thirdly, a hypothesis or hypotheses are developed ; and finally, the hypothesis or hypotheses are tested and subject to revision and modification. These steps may not necessarily be followed rigidly. However, pupils should use the methods of science in conducting experiments so that results are unbiased and objectives.

The Importance of Science

More time, no doubt, is devoted to teaching elementary school science than ever before. The writer can well remember attending a five teacher rural elementary school when science was taught once a week on the intermediate and upper grade levels in the later 1930's and early 1940's. The science curriculum then consisted largely of reading about science from a specific series of textbooks. The reading was generally done orally with each pupil taking his turn. Many students in graduate and undergraduate classes of the writer attending the elementary school years in the 1930's and 1940's mention similar learning experiences. The use of experiments in elementary school science has been discussed previously ; experimentation should be central in a modern program of science. The time, of course, devoted to the teachings of science has increased much.

There is much for pupils to learn in science in a scientific age. The space age, jet planes, cars, trucks, buses, ships, refrigerators, ranges, washers, and driers—to mention a few of man's achievements—require that pupils understand and develop major concepts, principles, and generalizations of science. This means that adequate time needs to be given to the teaching of science.

Many elementary schools have adequate time devoted each day to the teaching of science. To be sure, ample time given to teaching a specific curriculum area will not automatically make for optimum achievement on the part of pupils. However, if pupils are to realize carefully selected objectives, the proper amount of time needs to be given to provide for quality learning activities in elementary school science and evaluate if stated goals have been achieved.

Thus, society has realized the importance of science for pupils in the elementary school. If learners are to do well in science on the secondary level, they need to experience an excellent science program on the elementary level Young children are curious about their natural environment. Selected pupil have come to school late on the kindergarten and first grade levels due to being curious about insects, rocks, plants, snow, puddles of water, and other natural phenomenon while walking to school.

Teachers have been amazed about the items children will bring to school for a science learning center. Little or no coaxing needs to be done here. Pupils voluntarily want to bring objects to school pertaining to the curriculum area of science. They may bring rocks, insects in containers, tadpoles in jars, plants, magnets of different kinds, and other items related to science. Pupils can raise many important questions on what has been brought for the science learning center. Pupils may reveal their interests by asking questions such as the following :

(1) What do insects feed on ?
(2) How are rocks formed ?
(3) How do tadpoles change into frogs ?
(4) What do plants need in order to grow?
(5) Why do magnets "pick up" certain things but not other materials ?

Pupils with teacher leadership can discuss possible answers to these questions. Research also will need to be done to get needed information in solving problem areas. The area of science offers many occasions for pupils to develop interest in and become curious about natural phenomena. It almost appears that pupils are naturally interested in science. Thus, it is no wonder that elementary school science is receiving more emphasis than ever before in the elementary curriculum. Also, in an indurstrial, automated society, pupils must understand contributions that science has made to improve the quality of living for human beings.

Inservice Education in Science

With more science taught in the elementary school curriculum than ever before, it has become very important to conduct an adequate number of workshops and hold an ample number of faculty meetings to update science in the elementary school.

An elementary school or several elementary schools conducting workshops in the teaching of science must, first of all, determine what facet or facets of the science curriculum need to be emphasized in this approach to inservice education. Cooperatively, then, faculty members should decide upon the theme of the workshop. The theme can be decided upon only by studying trends in elementary school science and evaluating where one's school is presently in this important curriculum area. Thus, a gap will generally exist between where the school is presently and where it should be in elementary school science. The following areas may represent some of these gaps :

(1) objectives of elementary school science.
(2) selection of unit titles.
(3) proper sequence in the science curriculum.
(4) conducting experiments.
(5) using science equipment effectively.
(6) using a variety of learning activities.
(7) assessing pupil achievement effectively.
(8) developing a philosophy for teaching science.
(9) assisting pupils in reading science content.
(10) identifying the scope of the science curriculum
(11) learning by discovery in science.

Committees can be developed based on decisions made in the general session pertaining to problem areas that need solution in the area of elementary school science. It is excellent if each participant in the general session can select the committee he or she wishes most to participate in. Committee members need to sense purpose in work that is done. In other words, if participants can voluntarily select the committee they wish to serve in and sense that purpose is involved in solving problem areas, energy levels should be high for optimum achievement. The following resources should be available for all committee members :

(1) knowledgeable resource personnel who can work effectively with people.
(2) a professional library from which participants can get needed information.

Thus, members of the different committees involved in working to gain more insight into an effective elementary school science program should have resources available which will help in gaining quality results from effort put forth.

It is necessary for participants in a workshop to work on problems and areas of interest of their very own choosing. This would then provide for individual differences among committee members. It may be that one participant alone has the following problem pertaining to the teaching of elementary school science : assisting pupils in working on committees where responsibility of each member commensurate with ability is in evidence (this teacher may have had difficulty in getting certain committee members to do their share of the work). Thus, the individual participant in the science workshop can work in the direction of solving a relevant problem in the teaching of science. Consultant help and resource meterials would be available to help participants on an individual basis.

Faculty meetings in an elementary school should also be devoted to improving the elementary school science curriculum. An agenda committee composed of three or four faculty members can arrange items for discussion at the next faculty meeting. It is good to rotate the members of this committee to provide for a broad based of participation on the part of faculty members of an elementary school. Every faculty member should have equal rights to present items to the agenda committee for discussion at faculty meetings. The agenda should be in the hands of participants two to three days before the meeting is held. This should give all participants ample opportunities to think about the various alternatives and possibilities when discussing solutions to questions and problem areas.

Individuals can volunteer or be assigned to serve on committees to solve selected problem areas. Some of the problem areas that may be identified in faculty meetings pertaining to the teaching of elementary school science could be the following :

(1) How can the inquiry approach be utilized when teaching science ?
(2) How does one write objectives which are behaviourally stated ?
(3) How can pupil achievement be effectively evaluated when using the problem solving approach ?

Much thought, research, and discussion can go into the solving of each of these questions or problems. Some faculty members, no doubt, will need to visit other schools and observe teachers, for example, using the inquiry approach in teaching, as well as observe other innovations.

Developing Curriculum Guides

Each public school system should develop curriculum guides which can be utilized by teachers in teaching the different curriculum areas of the elementary school. Curriculum guides should be used in terms of providing suggestions for teaching. They should definitely not be descriptive In the early history of curriculum guides, it was felt that these were to be followed rigidly. Today, the emphasis definitely is upon selection, in terms of good criteria or standards, as to what will be utilized from a curriculum guide. The curriculum guide, along with other reference sources, can assist the science teacher to do a better job of planning for teaching elementary school pupils.

The question arises as to what are the salient parts of a good curriculum guide. The format followed in developing these guides may vary from school system to school system. However, there will be some basic agreements as to which essential parts to include in a curriculum guide. The following are important parts of a curriculum guide in terms of the section devoted to elementary school science :

(1) statements pertaining to a philosophy of teaching science.
(2) suggestions for using the guide.
(3) general and specific objectives for teaching different units of study,
(4) scope and sequence of science units for each grade in the elementary school.
(5) suggested learning activities for each science unit.
(6) suggested evaluation techniques to use in evaluating pupil achievement.
(7) a listing of child growth and development characteristics.
(8) suggestions for implementing committee work, and teacher-pupil planning.
(9) suggestions for helping pupils learn inductively, use the problem solving approach, and learn through the inquiry approach.
(10) a good bibliography listing teacher references and pupil references.

From the preceding parts that could go into the developing of a curriculum guide, it is quite obvious that the teacher can have a valuable source of ideas to use in planning the science curriculum. For example, the teacher can evaluate and select objectives which pupils should achieve in a specific unit. The teacher also has numerous opportunities to select learning activities from the curriculum guide which should help a given set of learners achieve to their optimum. The evaluation section of the guide should give the science teacher some new approaches to utilize in effectively evaluating pupil achievement. Again, curriculum guides must be used as guides and not as a holy book which must be followed precisely.

Use of Television in Science

Educational television has made many important contributions in upgrading the science curriculum. Elementary schools that have access to closed-circuit television generally will have listings of programs which teachers will have well in advance of their showing. These programs will relate directly to ongoing units being taught in science. For each unit of study, guides have been or should be developed pertaining to the different telecasts. For each broadcast, a listing of objectives for pupils to achieve is important. The teacher can sense then what each broadcast will emphasize in terms of objectives. Suggestions for learning activities are presented in the guide which will provide readiness within learners for viewing the telecast. The teacher can then select which activities would do the best job of providing readiness for learning so that adequate background knowledge will be developed within pupils. If pupils do not have the needed concept, facts, terms, and generalizations necessary for understanding the telecast, optimum achievement cannot result. The readiness activities should also assist pupils in developing interest in the broadcast. An inward desire should exist on the part of the learner in wanting to watch the telecast. Certainly, learners should have identified some questions which they would want to have answered when viewing the broadcast.

After the telecast, follow-up activities are necessary so that pupils can use what has been learned. Answers to questions raised before the broadcast can be discussed. Experiments may need to be performed in order that pupils can get needed data in answer to questions. Pupils may volunteer to develop reports on selected topics which relate to the broadcast using science encyclopaedias or regular encyclopaedias. Taking an excursion may help to answer additional questions raised after the telecast. In other words, there are many learning activities for pupils which will assist them to "branch out" in broadening their thinking and interests after having viewed a telecast.

Using Knowledge of Children

Science teachers who do a poor job of teaching may not be using knowledge pertaining to important child growth and development characteristics. Teachers need to study each of their pupils carefully so that the best quality of learning activities can be provided. Educational psychologists have long emphasized the importance of providing for individual differences in a class. Too frequently, however, little has been done in this area by practitioners. A very clear violation of providing for individual differences exists when science teachers want to keep all pupils "together" by having the whole group study the same thing at the same time. Perhaps, science has become a reading course where pupils spend much time in reading content from a series of elementary school science textbooks. As educators should be well aware of, this activity will be too difficult for some pupils; for others it is too easy. Very few pupils will find that the content is written on their reading level. Pupils also desire new experiences and want variety in learning activities they are participating in.

Many statements have been written on child growth and development characteristics. Faculty members of an elementary school need to study these contributions written by psychologists and educators realizing that pupils differ from each other in many ways within a class, such as interest, intelligence, abilities, past experiences, motivation, appearance, height, and weight.

Variety in Learning Activities

It is important for the science teacher to provide a variety of learning activities for pupils. This would be important for the following reasons :

(1) pupils have different learning styles.
(2) different levels of achievement in science exist within any class of pupils.
(3) not all pupils, of course, benefit equally form the same activity.
(4) teachers have different teaching styles.
(5) selected learning activities capture the interests of pupils more than do other kinds of experiences.
(6) individuals desire new experiences.
(7) monotony in activities hinders pupils in developing proper motivation toward learning.

There are many learning activities in elementary school science which would assist pupils in gaining needed concepts, main ideas, facts, and generalizations. These learning activities could help pupils in the area of problem solving. The following, among others, could become purposeful learning activities for pupils in elementary school science : conducting experiments and demonstrations, taking excursions, reading from a series or several series of elementary school science textbooks, getting information from a set or several sets of general encyclopaedias and/or science encyclopaedias, reading from library books, working at learning centers, using pictures, using transparencies and the overhead projector, constructing objects, making models, utilizing filmstrips and films, listening to tape recordings, interviewing resource personnel, viewing slides, visiting museums, having discussions, giving oral reports to the class, writing reports, engaging in dramatic activities, making dioramas, developing friezes, completing murals, making graphs and charts, developing illustrations, and participating in panel discussions. There are many, many kinds of learning activities for pupils in elementary school science ; there should basically be no boredom on the part of pupils when this curriculum area is being taught. It is important to select those learning activities which will help pupils to do the very best possible in elementary school science.

Approaches to teaching science can also be varied in terms of using the inductive versus the deductive approach to learning. Much has been written about the advantages of using the inductive approach as compared to the deductive approach. Some of these advantages are the following :

(1) pupils have to do much responding so that generalizations and conclusions can truly be discovered.
(2) learners reveal where they are presently in achievement when learning by discovery.
(3) pupils can become actively involved in ongoing learning activities.
(4) it keeps learners "on their toes" when doing much responding in on-going learning activities.
(5) pupils have many opportunities to dc critical and creative thinking.
(6) a variety of learning activities can be utilized in the inductive approach.
(7) pupils can become more self-directed with less reliance on the teacher dominating the classroom situation.
(8) teachers become more flexible in their thinking when less reliance can be placed upon how pupils will respond.
(9) learners can work more in the direction of using the methods and approaches of scientists; scientists gain much knowledge and information through discovery.

The science teacher can have pupils develop generalizations deductively For example, in a unit on "Liquids, Solids, and Gases", the teacher could perform an experiment whereby a bottle with a narrow opening would be filled with a few inches of water and placed on a hot plate. A balloon would be stretched over the narrow opening of the bottle before it is placed on the hot plate. Pupils would be encouraged to see what will happen. The balloon, of course, becomes larger. The teacher then proceeds to explain to the class why the balloon became larger and what happens when air is heated.

In the inductive approach utilizing the same experiment, the teacher could have pupils hypothesize freely as to what will happen when this same bottle. containing a few inches of water, with the attached balloon is placed on the hot plate. Reasons for the hypotheses can also be discussed thus giving the teacher much information on where learners are presently in achievement pertaining to the area now being taught in the unit "Liquids, Solids, and Gases". Following the discussion, the hypotheses need to be tested using the experiment. The experiment can be performed more than once so that pupils can sense that the outcomes in the experiment will have the same results. The size of the openings of the bottles as well as the size of the balloons can vary when having pupils view the same kind or type of experiment when noticing that the results are similar in terms of generalizations or conclusions realized. Further research can be done using elementary science textbooks, encyclopaedias, films, filmstrips, and other resources to explain conclusions realized from conducting the experiment. In using the inductive approach, the teacher does a very small amount of explaining or lecturing, The teacher sets the stage for learning. Pupils identify problems, gather information, develop hypotheses, test hypotheses, and revise them when necessary. Active involvement on the part of pupils is of utmost importance in ongoing learning activities.

A science teacher could tape record his own teaching and evaluate the quality of experiences pertaining to pupils learning by discovery or using the inductive approach. If a portable video-tape machine is available in the elementary school, teaching performance in science could also observe non-verbal facets of communication such as gestures, facial expressions, and body movements in the teaching-learning situation. Valuable feed-back from learners can come from viewing different facets of teaching on video-tape. The teacher can notice such factors as the following :

(1) Do pupils appear interested or bored in the ongoing learning activities ?

(2) Are all learners actively involved in the lesson being presented ?

(3) Do a few pupils dominate the discussion while others refrain from participating ?

(4) Do pupils feel free to hypothesize pertaining to possible outcomes of science experiments ?

(5) Are pupils using a variety of reference sources in gathering data to develop and/or test hypotheses ?

(6) Do pupils reveal curiosity in wanting to learn more about any unit of study in elementary school science?

If the teacher has access to video-taping teaching performance, or if a tape recorder is used only, he can analyze what kind of verbal interaction occurred between pupils and the teacher in a classroom situation. The teacher, for example, can notice the following in teaching-learning situations :

(1) Do pupils have ample opportunities to hypothesize ?

(2) Does the teacher ask many relevant questions of learners pertaining to ongoing units of study in science ?

(3) Are these questions on the present achievement level of pupils ?

(4) Do pupils have needed background information to develop meaningful hypotheses ?

(5) Is lecturing minimized much in ongoing learning activities ?

(6) Is the teacher praising pupils in achieving desired objectives in elementary school science ?

(7) Do learners identify relevant problem areas ?

(8) Does it appear that pupils individually are being challenged in developing an inward desire to learn ?

(9) Does the teacher give pupils adequate time to engage in hypothesizing when being involved in problem solving activities ?

(10) Does the teacher refrain from scolding or minimizing pupils in the class setting ?

Behavioural Objectives in Elementary Science

Elementary school science lends itself very well to having teachers state their objectives behaviourally. Selected educators advocate that objectives be stated precisely. Advantages of behaviourally stated objectives are the following :

(1) These objectives very clearly state what learners are to learn.

(2) It can definitely be measured if pupils have achieved these objectives.

(3) Learning activities can be selected carefully which will guide learners to realize the objectives.

(4) Teachers can be held accountable for pupils realizing the objectives.

(5) Learners can achieve these objectives at different rates of speed thus providing for individual differences.

(6) Parents can notice specifically what their pupils have learned.

(7) Principals and supervisors can have a better basis for evaluating teacher performance.

(8) Teachers could even be paid on the basis of achievement or lack of it in terms of learner performance (this could be a motivating factor for some teachers).

(9) Objective criteria are used to assess pupil achievement ; these criteria are the behaviourally stated objectives.

As in almost any innovation, there are also disadvantages to behaviourally stated objectives. The following, among others, are some of the disadvantages :

(1) Too frequently, the trivial or unimportant is taught since the lowest level of cognitive objectives are easiest to write.

(2) No one can definitely be sure what pupils actually should learn when stating all objectives precisely prior to teaching.

(3) Objectives should come from the learner also and not the teacher only.

(4) Affective domain objectives may become minimized if all objectives need to be stated so that it can be measured precisely if pupils have achieved them.

(5) Learners become rather passive individuals if all objectives are stated by the teacher prior to teaching.

(6) By stating objectives in advance prior to teaching, the teacher is assuming that proper sequence in learning will be in evidence.

(7) The teacher should focus more on the learning activity rather than the objectives since it is in this framework that interest and meaning is developed.

(8) Behavioural objectives are very time consuming in writing.

The science teacher, the elementary school principal, and the supervisor need to study behavioural objectives carefully to determine if this plan of teaching is really wanted in elementary school science. Workshops and faculty meetings can be devoted to the study and implementation of behavioural objectives. Objectives which pupils are then to achieve should meet the following criteria :

(1) they are important or relevant.
(2) they stress key ideas or generalization emphasized by specialists in the different areas of science such as in biology, chemistry, physics, zoology, botany, geology, and astronomy.
(3) there is balance among understandings, skills, and attitudinal objectives or among cognitive, psychomotor, and affective domain objectives.

All behaviourally stated objectives should follow the following standards :

(1) the objectives should be clearly written so that little or no room exists in their interpretation.
(2) it can definitely be measured if the objectives have been achieved.
(3) it states what learners will learn as a result of teaching.

If pupils are studying a unit on "The Solar System". the following objectives may have been identified for pupils to realize :

(1) The pupil will list in writing the nine planets in proper sequence from the sun.
(2) The pupil will recite orally the names of the largest and the smallest planet.
(3) The pupil will write a fifty word paper on the possibility of life as we know it on a planet of his own choice (excluding the planet earth).
(4) Pupils in their own words will define the meaning of the following concepts; solar system; universe; planet; satellite; asteroids; theory; hypothesis; magnetic pole; constellation; rotation; and revolution.
(5) The pupil will demonstrate and discuss the causes of the different seasons of the year.
(6) Learners will predict what will happen in the future in space exploration.
(7) A model of the solar system will be made in committees of three ; the model will be evaluated in terms of criteria discussed in class.

The first and second behaviourally stated objectives require recall of information which is the lowest level of cognition. Pupils would recall the names of the nine known planets in proper order, and be able to name the largest and smallest of these planets. The third objective may also involve simple recall of what has beeh learned previously by pupils. Pupils could recall from a discussion if there is or is not life as we know it on one of the planets and write on the selected topic. Pupils individually, however, could also be quite creative when writing a paper of at least fifty words pertaining to the possibilities of life existing on a planet which he chooses to write on. The paper could involve unique, novel, original, and constructive ideas which would involve synthesizing of knowledge. The fourth objective goes beyond recall of knowledge. It is true that the child would need to think of definitions he has heard of previously pertaining to such words as solar system, universe, planet, satellite, asteroids, theory, hypothesis, magnetic pole, constellation, rotation, and revolution. The learner, however, would need to reveal his understanding of these concepts by giving definitions in his own words. Comprehension of the meaning of these concepts would be important to pupils when achieving this objective. The fifth objective would generally involve applying what has been learned previously. The knowledge and information the child has developed previously is now utilized in demonstrating the causes of the different seasons of the year. The pupil could use a large globe to represent the earth and a flashlight to represent the sun. The learner could also make drawings on the chalkboard and/or use pictures in clarifying the various causes for the different seasons of the year. In the sixth objective, creative thinking based on much knowledge is involved. Pupils would need to have considerable background information to make predictions as to what will happen in the future as far as space exploration is concerned. The last objective involves a psychomotor domain objective in that a construction activity is involved requiring the use of the muscles. To be sure, much thought and research will go into the making of an accurate model of the solar system. Pupils will need to check the accuracy of their model in terms of standards or criteria developed in class. The latter part of this objective (objective number seven) can involve a very complex level of thinking. Definite criteria will need to be developed in class so that the model of the solar system can be effectively evaluated in terms of these guidelines.

Thus, behaviourally stated objectives can be used effectively in a modern program of elementary school science. It is important when emphasizing these kinds of objectives that teachers have pupils go beyond the level of recall of information. The science teacher also needs to think in terms of some kind of rational balance among cognitive, psychomotor, and affective domain objectives. Never should one category of objectives dominate teaching-learning situations. One category of objectives does affect the other category or categories.

Adjusting the Science Curriculum to the Child

Too frequently, the teacher has objectives for pupils to achieve which are excessively complex. The science teacher may have felt that this is a way of setting high standards in a specific curriculum area. Many pupils then cannot achieve these objectives and develop feelings of an inadequate self. Pupil achievement goes downhill in situations such as these. Learners think and feel that they cannot do well in elementary school science and this becomes a reality. If pupils perceive that they cannot do well in science, this is the way that learners will behave. The teacher needs to have some kind of pretest in a new science unit to determine where learners are presently in achievement. Once this has been determined, objectives can be developed which are attainable. If objectives are attainable, learners can feel successful and develop feelings of an adequate self. The curriculum is then adjusted to where pupils are presently in achievement in different units of study in elementary school science.

Certainly, there is danger, too, in teaching pupils what they already know in a new unit of study. A pretest can give elementary science teachers data if objectives need to be made more complex. Again, the objectives should be attainable for learners. The science curriculum in this case is again adjusted to present achievement levels of learners.

Summary

Conducting experiments is a very important type or kind of learning activity in a modern elementary school science program. Balance among the different curriculum areas in the elementary school must be stressed in teaching-learning situations. Inservice education for teachers, principals, and supervisors is important to update the science curriculum. Curriculum guides can be a valuable source to utilize when selecting objectives, learning experiences, and evaluation techniques in a modern program of elementary school science.

A variety of learning experiences should be provided for pupils in the elementary school. The science curriculum must be adjusted to the present achievement level of each learner. Inductive approaches should be emphasized by the teacher in teaching-learning situations; critical and creative thinking as well as problem solving should be emphasized. Attitudinal objectives are important for pupils to achieve. There must be proper balance among the following kinds of objectives for pupils to achieve :

(1) understandings, skills, and attitudes or
(2) cognitive, affective, and psychomotor domains.

Adequate emphasis needs to be placed upon microcomputer instruction in the curriculum. Wright and Forcier list the following general criteria in selecting computer courseware :

(1) Content is accurate.
(2) Content is appropriate.
(3) Presentation is clear.
(4) Screen display is highly readable.
(5) The computer's capabilities are effectively employed.
(6) Program executes reliably.
(7) Program is cost effective.
(8) Program is easy to use.
(9) Support materials are effective.
(10) No racial or sexual discrmination implied.

Reference

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Measurement of Acoustic Noise

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DURING THE last few years more and more people have become concerned about the problem of environmental noise which is defined as the unpleasant sound. It is necessary to control the noise level as much as possible to avoid the danger of hearing loss which can result from an exposure to high noise levels. Besides, the bad psychological effects of noise are well known. It acts as an irritant in most of the cases. Noise pollution is present almost everywhere in our cities—at the place of work (factories, offices etc.), on the road and at home. Most of the countries, now-a-days, have legislations fixing the noise limits for different situations. This has led to a greater appreciation of the benefits of a quiet environment and a preference for quieter industrial and domestic products. In many cases, the quieter product can function as well as the noisier one, and the increased cost of reducing the noise may be minor. So a quieter item has a sales advantage over its noisier competitor. The aim of acoustic noise measurement is to provide objective physical measurements of noise which can be compared with predetermined criteria to judge its acceptability. There are international standards for measuring equipment and the measurement procedure in order to ensure the quality and uniformity of the measurement results.

Measuring Scale for Noise

Normally, the sound pressure and not the intensity of the sound field is used as the measurement parameter, because it is easier to measure sound pressure than sound intensity. The use of linear scale for measuring sound pressure would create a problem, because the quietest sound at 1000 Hz that can be heard by an average person is about 20 μ Pascals (Pascal, abbreviated Pa, is Newton/meter^2) while at the other end of the scale the threshold of pain occurs at a sound pressure of approx. 100 Pa. This gives a ratio of more than a million to one. So the use of linear scale would lead to the use of enormous numbers. In addition to this the human ear does not respond linearly but logarithmically to the stimulus. So it is more practical to express acoustic parameters as a logarithmic ratio of the measured value to a standard reference value. The resulting unit, called the Bel is defined as the logarithm to the base ten of the ratio of two acoustical intensities, or powers. A unit one tenth of Bel, the decibel (dB) is in general use. As the acoustic intensity, the power passing through a unit area in space, is proportional to the square of the sound pressure, the scale for acoustic measurements is defined as

$$\text{Sound Pressure Level (SPL)} = 10 \log_{10} \left(\frac{p}{p_0} \right)^2$$

$$= 20 \log_{10} \frac{p}{p_0}$$

Where,

p : Sound pressure being measured

p_0 : Reference sound pressure taken as 20 μ Pa

The use of decibel scale, thus, reduces the hearing range of sound pressures of a million to one to a more manageable range of sound pressure levels of only 0 to 120 dB. Zero is the reference minimum threshold and 120 the approx. threshold of pain. Care must be taken while dealing with addition or subtraction of decibels. They should be converted to relative powers, added or subtracted and then converted back to decibels. Thus a noise level of 80 decibels combined with a noise level of 80 decibels will not yield 160 dB but 83 dB.

The response of human ear to noise is frequency dependent. Loudness levels are derived as contours of sound pressure levels of simple tones over a range of frequencies, each contour representing a constant apparent loudness. These are known as equal loudness curves. The loudness level in phons of each contour is defined by the sound pressure level in dB at a frequency of 1000 Hz in the contour. To obtain a satisfactory relationship between an objective measurement of sound pressure level and subjective response to that sound level, the sound level meters are provided with frequency weighting network. These modify the meter response, by using electrical filtering network, to follow approximately the equal loudness curves at 40, 70 and 100 phons. These are known as A, B and C weighting respectively. Out of these, A weighting is the most commonly used. The meter reading obtained using these weightings must be specified as dB (A), dB (B) or dB (C) as the case may be.

Some of the typical A-weighted noise levels are given below. [3]

Noise Source (at a given distance)/Environment	Noise Level dB (A)
Speech Studio	30
Soft Whisper (1.5m)	35
Large Office	50-60
Speech (0.3m)	70
Subway Train (6m)	90
Large Diesel Generator Set (1m)	100
Jet Takeoff (60m)	120

Sound Measuring Instruments

The basic instrument of a sound measuring system is the sound level meter. A simple sound level meter comprises, an omnidirectional microphone (usually a condenser microphone) coupled to an amplifier to convert sound pressure level to a proportional electric signal indicated by a meter. The actual sound pressure level is alternating from positive to negative levels, so rectification is necessary to send a dC signal input to the meter. In practice the signal is squared which has the effect of producing all positive signals continuously varying in amplitude. To get a steady level for meter indication this signal is then put through a time constant small enough to rate continually changing levels over short periods. The immediate reading at any instant is an average over that particular time constant. So, basically, the instrument consists of a microphone, a calibrated alternator, weighting networks, a stabilized amplifier, a squarer, an averaging circuit and an indicator. Often the overall noise level is not sufficient and for a more precise analysis of frequency effects it is necessary to measure the sound level in selected frequency bands. This can be achieved by using a filter circuit providing a number of passbands, so that measurement of sound level can be made separately for each passband or frequency band. These frequency bands are either arranged in octaves (with upper and lower frequencies in each band in the ratio of 2 : 1) or in narrower widths such as one third octave.

Figure 1 shows the basic block diagram of a noise measuring system. [1]

The sound level meter is a portable hand held instrument and may include a built-in octave filter for frequency analysis of the noise signal. Such instruments are very useful for the field measurements of noise. Alternatively a laboratory set up

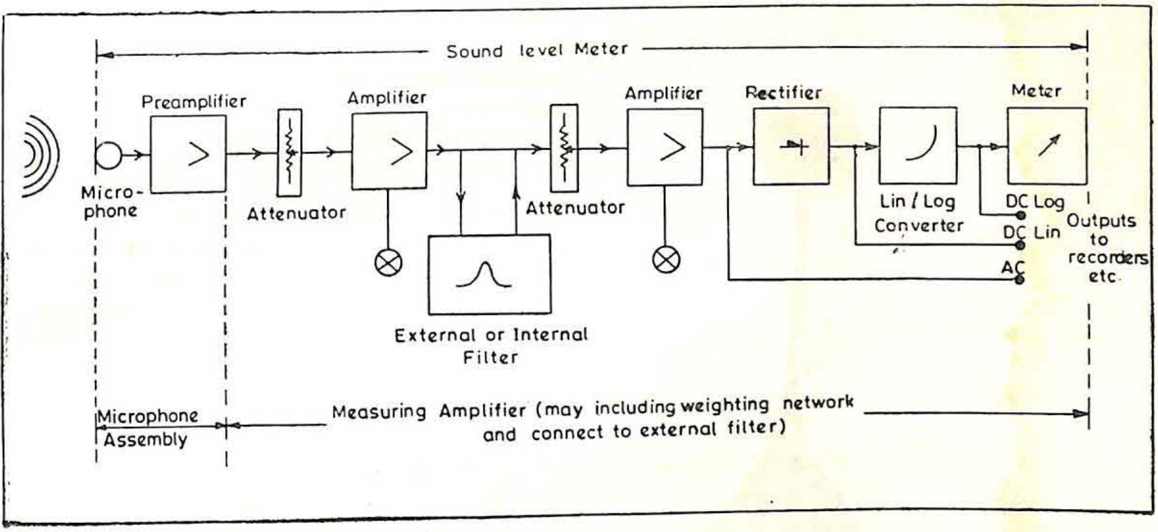

Fig. 1. Block diagram of a noise measuring system.

consisting of a microphone, a preamplifier and a measuring amplifier which may include weighting network, can be used. A filter set can be added to this set up for frequency analysis work and frequency versus amplitude plots can be obtained using a level recorder.

Impulse type of noise such as that produced by punch presses or drop hammers cannot be properly measured with the normal time constants as it is not sufficiently short to give a meter indication representative of the subjective human response. To measure such signals properly a special circuitry is incorporated in the sound level meters to detect and display transient noise taking into account the human perception of impulsive sounds.

The noise level at a particular instant is not a good measure of noise whose level varies with time over a wide range. One of the descriptors developed taking this variation into account is called the Equivalent continuous noise level with the symbol "Leq". It is the A-weighted energy mean of the noise level averaged over the measurement period and is defined as :

$$\text{Leq} = 10 \log_{10} \frac{1}{T} \int_{0}^{T} \frac{(p_A(t))^2}{(p_0)} \Big\} dt$$

Where,

T = Total measurement period

$p_A(t)$ = A weighted instantaneous acoustic pressure

p_0 = Reference acoustic pressure (20 μ Pa)

Sound level meters which measure this parameter directly, are now, available. Leq is now a widely accepted parameter for 'noise dose' measurement and is used for rating community noise. Figure 2 (right) shows the photograph of a sound level meter having the additional facilities of impulse noise and Leq measurements. The spherical ball over the microphone is a foam windscreen used to reduce the effect of wind noise, in outdoor measurements.

Measuring Methods

The presence of any object in the sound field has some effect on the sound pressure actually measured at the microphone. Reflections from the object alter the local field. The reflections from the observer affect the accuracy when the measurements are made with the sound level meter held close to the body of observer. In the case of hand held instrument, it is generally recommended that the meter be held well in front of the observer, with the noise source located to one side. The background noise should be at least 10 dB below the noise level of the source to be measured. The standards specify the exact procedure for noise measurements. For example for vehicle noise measurements, the distance and height at which the microphone should be placed from the centre of the road, the distance the vehicle has to travel in front of the microphone, environmental conditions etc. are all specified. Some of the noise measurements are required to be made in special rooms like anechoic room or reverberation room. The anechoic room by the use of highly absorbent surfaces reproduces conditions where reflected sound is almost absent. While on the other hand reverberation room has very little sound absorption and the sound from a source in such a room is reflected many times, as it bounces back and forth on the surfaces of the room.

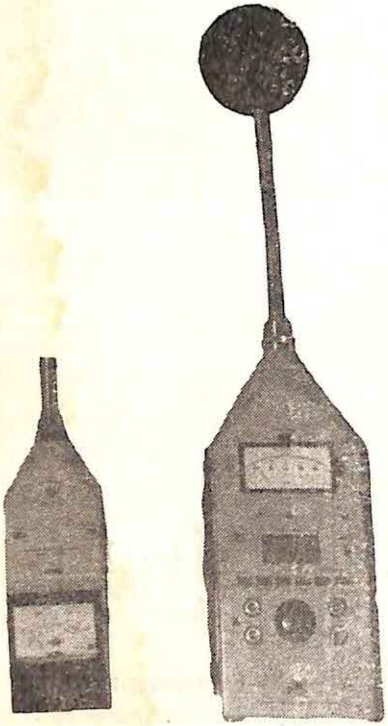

Fig. 2. Sound level meters

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Development of a Low-cost Overhead Projector

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Conventional Overhead Projector (Employing Fresnel Lens and Projection lamp).

AN OVERHEAD projector is a powerful teaching aid which facilitates the projection of diagrams, writings and even experiments. Over head projector was developed to meet specific training needs during World War-II. By 1960 it became extremely popular in schools, colleges, business and industry. For this projector, illustration materials are first transferred on transparent sheets which can be used repeatedly. The user can write or draw directly on the transparent sheets. The projection screen can be above or behind the speaker who can write, sketch and erase during his talk or conversation. Important psychological techniques including progressive disclosure can be used effectively in the overhead projector.

OHP can be used in a lighted class without darkening the room. One transparency can be placed on the top of another so as to present information in almost any combination one desires. The transparency is made of clear acetate or plastics, sizes may be 3″×4″ 7″×7″, 10″×10″, commonly $8\frac{1}{2}$″×11″. OHP is an excellent replacement for the chalk board with the special advantage of projecting prepared materials including even some experiments. These can be made extemporaneously in the same way a chalk board is used. Other advantages are :

(*a*) The teacher can watch the students while using OHP.

(*b*) Bright image can be projected in fully lighted room. This permits the teacher and learner to see each other.

(*c*) The equipment is simple to use.

Some Features of Conventional OHP

The distance between the projector and the screen and corresponding image size is given below :

TABLE 1

Projector to Screen distance, ft.	*Image size using 10″×10″ Opening, inch*
4	32×32 (3.2 times)
6	48×48 (4.8 times)
8	64×64
10	80×80
12	96×96
14	112×112 (11.2 times)

Such a powerful audiovisual equipment has a few disadvantages also :

(*a*) It is beyond the reach of an average school due to the fact that price is prohibitive. Price (Oct. 1984) quoted by one of the manufacturers is :

	Rs.
Projector	2995
Roll 15 metres	175
Screen	190
Lamp	350
	Rs. 3710 plus tax

(*b*) The projection lamp may have a power rating between 300 watts to

1000 watts. High cost apart, availability of a particular specification of an imported projector lamp becomes a problem even in big cities.

(*c*) Replacement of any lens in case of breakage etc. is very difficult as those are not of very common specifications. Fresnel lens continues to be imported. Imported one of 10″×10″ costs Rs. 550/-.

(*d*) Sometimes image appears in a tranpezoic form in the conventional OHP; this is a defect called 'key stoning'. This can be rectified by tilting the screen to make it perpendicular to the line of projection. This tilting is bothersome.

(*e*) If the screen is not permanently fitted on the wall, storage of screen sometimes poses problem.

Design of a Low-cost OHP

As Fresnel lens is not manufactured in India, it was not found proper to incorporate a Fresnel lens in the optics of the indegenous OHP. Rather the maximum size of the double convex lens available with ordinary (not precision) optical industry was tried. Imaging effect of lens primarily depend on its surface curvature while thickness has a second order effect. Same focussing effect can be obtained if the surface is divided into small elements and these are brought in a common plane normal to the optical axis. Such small segments destroy the continuity of wave front and so those lenses do not have high performance but are useful in OHP applications. Such lenses are also used in motor car headlights. Here the segments are unsymmetrically arranged to direct the light of the head lamp so as to form a shaped beam. Such lenses may be several ft. in diameter and 1/8″—1/4″ thick. Relative aperture of f/0.5 (f/(f/pupil dia)) is common. Most of the light is collimated by the paraboloid reflector; this type of lens is used in small searchlights and in projectors in lighthouses. Fresnel lens can be used as condeser or a collimator. Its advantages are : light weight, cheap, light transmission equivalent to a glass lens, it is corrected for spherical aberration and is unbreakable; it can be cut and given any shape, fitting and replacement are economical. CSIR, Chandigarh has brought out a lens by pasting two lenses back to back with grooved faces outside, the f.l. of one (8″) being shorter then the other (13″).

The common sizes of Fresnel lenses are discussed below :

TABLE 2

Lens Size Cm×Cm	*F.L. Cm.*	*Pitch of grooves, Cm.*
5.5×5.6	7.5	0.0125
15×15	21.5	0.050
27×27	21.5	0.050
27×27	33	0.050
27 cm dia	21.5	0·050

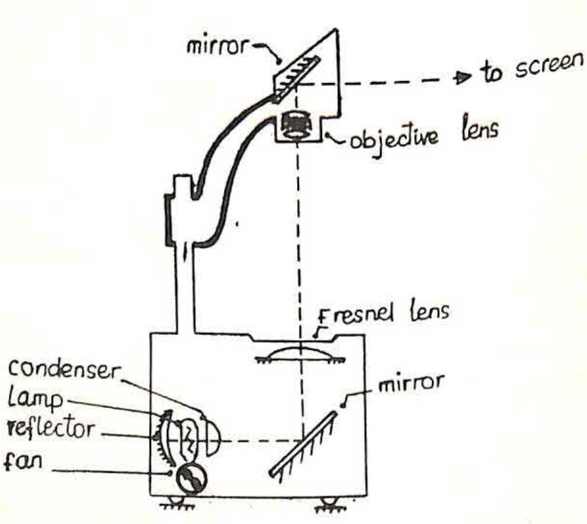
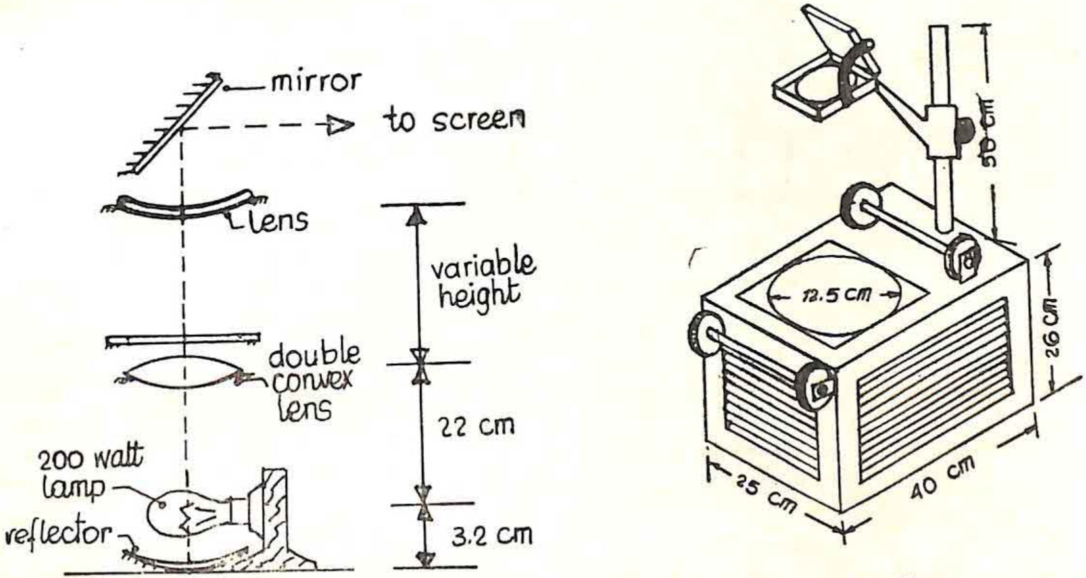


Fig. 1. Conventional OHP

In this low cost design, a double convex lens of ordinary glass f.l.33 Cms dia 17 Cms has been used in place of a Fresnel Lens. Fig. 2a shows the construction of such an OHP. Special care has been taken in plating chromium on the Copper reflector. The 200 Watt, 240 V ordinary bulb has a particular orientation in which maximum illumination at the screen is obtained.

Like the conventional projector, the low-cost one can be operated on a white wall (no special screen is required) in a lighted room. For best performance in the lighted room a distance of 6 ft. between the projector and wall need be maintained, At this distance the clarity etc. are satisfactory in a lighted room. However in a dark/semi-dark room this distance may be even 18ft. in which case the magnification is 16.8 times.



aFig. 2

FIG. 2b

Fig. 2. Construction of the low cost OHP.

The distance between the low cost projector and the screen and corresponding image size is given below :

TABLE 3

Projector to screen distance, ft.	*Image size using 5" dia opening, inch.*
6	28 (5.6 times)
9	42 (8.4 times)
18	84 (16.8 times)

This projector has a screen for rear view projection. Fig. 3, shows the arrangement for rear view projection. An additional plane mirror, one screen (60cm×45cm) of plastics cloth having microhombs and stands are required for this facility. These accessories along with the bulb can be packed in a wooden box which can go inside the main projector box.

We know that for optimum viewing of projected image the viewer should not be seated at a distance from screen closer than two times or further than the six times the screen width. Horizontal viewing angle on the screen may be between 60° to 120°. The optimum angle of elevation has been found to be 15° but may go upto 30°. In television the minimum viewing distance is four times the image width and the maximum is 12 times image width beyond which details within the image are not clear. Horizontal viewing angle on T.V. screen ranges from 70° to 80°.

The horizontal viewing angle of the rear view screen of the low cost OHP is around 90°.

In the rear view projection shown in Fig. 3, the screen is hung at distance of 142 cms (4'-8") from the projection axis for getting the maximum clarity in a class room having a good degree of illumination Rear view projection is very helpful in projecting even in open day light.

The recommended length of time for continuously running the projector is 3 hours. During summer when the room temperature is 33°C, inside temperature of the box reaches 52°C after 3 hours of continuous operation while the temperature of on the reflector surface reaches 90°C. Due to the natural draft the hot air inside the box goes out through sufficient number of openings on the walls. So no fan is required for cooling. However for trial on 1/650HP, 2600 rpm fan was fitted

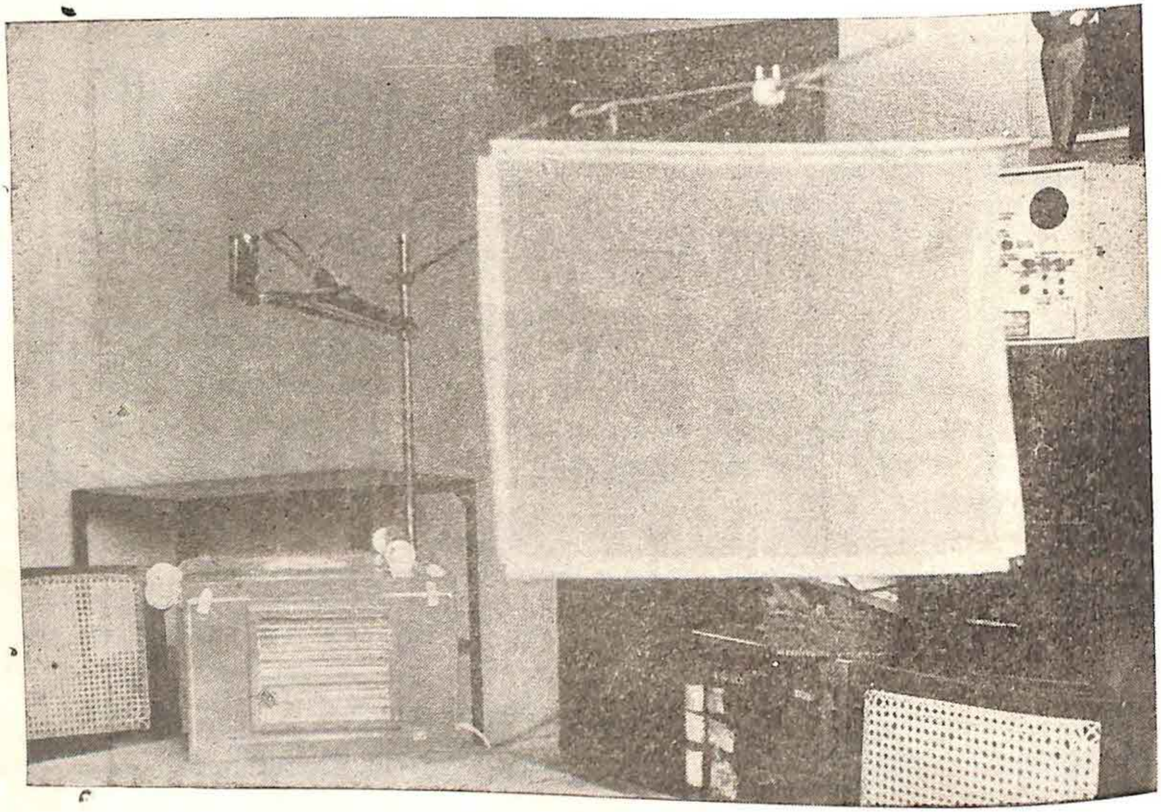


Fig. 3. Rear view projection from the low cost projector,

in the box and run for one hour. It was observed that the temperature on the reflector surface came down by nearly 20°C, but the minute vibrations of the motor disturbed the image.

The followings are the prices (material and labour) of the parts of the low-cost projector :

	Rs.
Body	60.00
Stand	15.00
Double convex Lens	130.00
Concavo Convex Lens	45.00
Roller	25.00
Lamp, 200 W	12.50
Reflector	15.50
Sliding frame	10.00
Plane mirrors	5.00
Inner wooden box	20.00
Screen	10.00
Transparent sheet 15 m (ordinary)	30.00
	Rs, 378.00

'Colo' brand sketch pens have been found to be most successful on ordinary transparencies. Their markings can be wiped with the help of petrol. Ordinary glass marker pencil can also be used on the transparency.

The low-cost overhead projector with the facility of rear view projection at one-tenth of the price of a conventional projector has been developed in the Workshop Department, NCERT recently. The author, Sh. Kamal Kishore, Junior Foreman and Shri Prithivi Singh, Lab. Assistant have been working on the design and will be happy to receive comments.

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Acc. no. - 15129

Prevalence of Intestinal Helminth Parasites in School Children of Erbil City, IRAQ

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A survey of human Intestinal helminth parasites was done during the period October '84—April '85 in Erbil City, Iraq. Faecal samples were examined from 500 primary Schaol Children. Parasitic infection of Ascaris lumbricoides; Enterobius vermiculars; Trichuris trichura; Hymenoiepis nana and Taenia saginata were found and the percentage of these infections were 16.0, 0.8, 0.2, 9.0, and 0.8 respectively.

INCIDENCE OF human helminth parasites have been reported from different parts. Some of them are those of Huang (1960); Ben-ari (1962); Veerannan (1977); Al-Geboori and Shafiq (1976); Al-Hanoon and Mukhlis (1982); Lal (1983). A survey of different literatures show that very little work has been done on the incidence of human helminth parasites in Iraq and hence this kind of work has been undertaken.

Material and Methods

A total of 500 (Five hundred) faecal samples were collected from school children aging from 6-13 years from 11 primary schools of Erbil City, Iraq. Fresh Stool samples were collected in sterile containers and brought to the laboratory within few hours for microscopic examination work. Stool samples were examined by Direct Smear Method (Chatterjee, 1969; page-199). Negative samples were re-examined one or two times more inorder to rule out the infection.

Result and Discussion

The prevalence of helminth infection in 500 faecal samples was found to be 26.8%. The parasitic infections which were seen are—*Ascaris lumbricoides* (16.0%); *Enterobius vermicularis* (0.8%); *Trichuris trichura* (0.2%); *Hymenolepis nana* (9.0 %) and *Taenia saginata* (0.8 %).

TABLE 1

INCIDENCE OF HELMINTH PARASITES IN 500 FAECAL SAMPLES OF SCHOOL CHILDREN OF ERBIL CITY, IRAQ.

Parasite	*Positive Samples Number*	*Percentage*
Nematode :		
Ascaris lumbricoides	80	16.0
Enterobius vermicularis	4	0.8
Trichuris trichura	1	0.2
Cestode :		
Hymenolepis nana	45	9.0
Taenia saginata	4	0 8
Total	134	26.8

TABLE 2

INCIDENCE OF HELMINTH PARASITE WITH REGARD TO SEX OF THEHOST.

Parasite			*Sex*	
	Male *Total—320*	%	*Female* *Total—180*	%
Nematode :				
Ascaris lumbricoides	52	16.25	28	15.55
Enterobius vermicularis	3	0.93	1	0.55
Trichuris trichura	1	0.31	0	0
Cestode :				
Hymenolepis nana	30	9.37	15	8.33
Taenia saginata	3	0.93	1	0.55
Total	89	27.79	45	24.98

Table 1 shows that the infection of *Ascaris lumbricoides* is highest in the examined samples and infection of *Trichuris trichura* is lowest.

Table 2 shows a sex wise break up of the infection. A perusal of this table shows that the differences in the infections in both sexes are not the same but still the differences are not very significant. It can be said that the over all infection rate is not influenced by sex.

Present work has been compared with works done in Iraq. Al-Geboori and Shafiq (1976) examined 240 school children of Baghdad (Iraq) and found the rate of infection of *Enterobius vermicularis* and *Hymenolepis nana* to be 10% and 15% respectively. Al-Hanoon and Mukhlis (1982) examined 164 faecal samples collected from Secondary School Children of Mosul (Iraq) and found the infection of *Enterobius vermicularis*, *Ascaris lumbricoides*. *Taenia saginata* and *Hymenolepis nana* to be 2.4%, 0.5%, 1.8%, and 7.9% respectively. The author (1983) reported from an area of Erbil (Iraq) the *Ascaris lumbricoides* infection in children to be 20.0% and in grown-up to be 7.8% respectively out of total 138 samples examined.

The present result shows that the infection rate of *Enterobius vermicularis* and *Hymenolepis nana* is lower in Erbil than one examined by Al-Geboori and Shafiq (1976) from Baghdad. The infections of *Ascaris lumbricoides* and *Hymenolepis nana* are higher and the infections of *Enterobius vermicularis* and *Taenia saginata* are lower in the present study than the one observed by Al-Hanoon and Mukhlis (1982) from Mosul.

The infection of *Ascaris lumbricoides* which has been reported from Mosul by Al-Hanoon and Mukhlis (1982) to be 0.5% appears to be very low and the climatic conditions of the place also do not warrant it to be so low and therefore a further investigation on *Ascaris lumbricoides* infection in Mosul City of Iraq would yield more information in this regard.

The *Ascaris lumbricoides* infection reported by the author (1983) from an area of Erbil is higher than the one observed in the present investigation. The higher infection is considered to be related to the fact that large portion of the area from where the samples were examined was slum area.

The author wishes to express his thanks to the authorities of Biology Deptt., College of Science, Salahaddin University, Erbil, Iraq for providing necessary research facilities.

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Creative Pupil Perception by Science Teachers

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A CULTURE may chaperon creativity, it may also belittle it. A creative act in a culture might as well be non-creative in another culture. For the development of creativity, influences of culture, motivation, and personality are important. Creativity bug resides in every child. But it isn't there in the classroom (Pachaury, 1980). A child's creative transaction is nurtured to the extent, he receives reinforcement for it, from the parents, the peers, and the teachers. Although, the role of the school in shaping creative personality of the child can hardly be denied, the teachers seem not to be favourably disposed towards creative pupil. Nurture of creativity in pupils, is then, contingent on the teachers creative attitudes and their perception of the creative pupil as supported by their culture. The present study was aimed at finding an answer to the following questions regarding science teachers:

(1) How do prospective and in-service science teachers perceive a creative pupil ?

(2) Is there any difference in the perception of the Bio-chem and the Phy-maths teachers of the creative pupil ?

(3) Is there any difference in the perception of the prospective and in-service science teachers and those of the 'creativity personality experts' ?

Procedure

The check-list used in this study. '*Your Ideal Pupil*' was developed by Torrance (1965) It consists of 62 characteristics and these were derived from over fifty research studies of highly creative and non creative individuals of similar background and experiences.

Sample

100 one-year B.Ed. science students and 58 in-service teachers (29 Bio-chem and 29 Phy-maths) formed the sample of the study. They were asked to check ten characteristics by putting *A*, which they considered most important and would specifically like to encourage them in their pupils. They were also asked to check another ten characteristics by putting *B*, which they considered should be discouraged or punished. Ranks were derived from the frequencies on 'desirable and undesirable' characteristics.

Results

I. Prospective Science Teachers' Perception of the Creative Pupil

Table I presents the rank order of the creative pupil characteristics which the prospective science teachers and the experts on the creative personality consider most and least desirable. The most liked characteristics of 'Independent in thinking, Curious and Courageous in convictions' are common to both the groups. For the least valued characteristics only one of those chosen by the teachers agrees with those chosen by the experts and it is 'timidity'. The characteristics chosen by these teachers as least valued are mainly traits which show non-conforming tendencies and attitudes which may lead to disruptive and non-cooperative practices among the pupils, *e.g.*, 'Distrubs class organization and procedures, Domineering, Un-willing to accept others ideas, Negativistic, Fault-finding, Timid. Critical of others and Intuitive'.

TABLE 1

THE MOST AND LEAST VALUED TRAITS OF THE CREATIVE PUPIL AS PERCEIVED BY THE PROSPECTIVE SCIENCE TEACHERS AND EXPERTS ON THE CREATIVE PERSONALITY

Experts on Creative Personality	*Prospective Science Teachers*
MOST VALUED TRAITS	
1. Courageous in convictions	1. Independent in thinking
2. Curious	2. Industrious
3. Independent in thinking	3. Obedient
4. Independent in judgment	4. Competitive
5. Becomes pre-occupied with tasks	5. Does work in time
6. Intuitive	6. Curious
7. Un-willing to accept say so	7. Courageous in convictions
8. Visionary	8. Sincere
9. Willing to take risks	9. Self-confident
10. Always asking questions	10. Receptive to ideas of others
LEAST VALUED TRAITS	
1. Conformity	1. Distrubs class organization and procedures
2. Willing to accept judgment of others	2. Un-willing to accept others ideas
3. Fearfulness	3. Domineering
4. Timidity	4. Negativistic
5. Obedience	5. Fault-finding
6. Courtesy	6. Socially timid
7. Promptness in doing work	7. Critical of others
8. Socially well adjusted	8. Stubborn
9, Haughty and self-satisfied	9. Intuitive
10. Neatness and orderliness	10. Timidity

TABLE 2

THE MOST AND LEAST VALUED TRAITS OF THE CREATIVE PUPIL AS PERCEIVED BY THE IN-SERVICE SCIENCE TEACHERS

Most Valued Traits	*Least Valued Traits*
1. Curious	1. Negativistic
2. Independent in judgment	2. Stubborn
3. Industrious	3. Disturbs class organization and procedures
4. Healthy	4. Timid
5. Does work in time	5. Bashful
6. Independent in thinking	6. Haughty and self-satisfied
7. Courageous in convictions	7. Talkative
8 Self-confident	8. Likes to work alone
9. Obedient	9. Always asking questions
10. Self-confident	10. Critical of others

II. In-service Science Teachers' Perception of the Creative Pupil

Table II presents the ranks of the creative pupil characteristics which the in-service science teachers and the experts on the creative personality consider most and least desirable. The most liked characteristics of 'Curious, Independent in judgment, Independent in thinking, and Courageous in convictions' are common to both the groups. For the least valued two traits chosen by these teachers agree with those chosen by the experts. They are : 'Timidity, and Haughty and self-satisfied'. Most of the characteristics chosen as least valued by these teacher show non conforming tendencies in the pupils. *e.g.*, Like to work alone, Always asking questions, Critical of others, Disturbs class organization and procedures, and Negativistics.

III Bio-chem Teachers' Perception of the Creative Pupil

Table III presents the rank order of the creative pupil characteristics which the Bio-chem teachers and the experts on the creative personality consider most and least desirable. The most liked characteristics of 'Curious, Independent in judgment, Independent in thinking, and Courageous in convictions' are common to both the groups. For the least valued, two traits chosen by these teachers agree with those chosen by the experts. They are : 'Timidity and Haughty and self-satisfied'. Most of the characteristics chosen as least valued by these teacher show non-conforming tendencies in the pupils, *e.g.*, Disturbs class organization and procedures, Negativistic, Likes to work alone, none-conforming and Always asking question.

TABLE 3

THE MOST AND LEAST VALUED TRAITS OF THE CREATIVE PUPIL AS PERCEIVED BY THE IN-SERVICE BIO-CHEM TEACHERS

Most Valued Traits	*Least Valued Traits*
1. Curious	1. Distrubs class organization and procedures
2. Independent in judgment	2. Negativistic
3. Adventurous	3. Stubborn
4. Industrious	4. Timid
5. Healthy	5. Haughty and self-satisfied
6. Willing to take risks	6. Bashful
7. Independent in thinking	7. Talkative
8. Courageous in convictions	8. Likes to work alone
9. Self-assertive	9. Non-conforming
10. Sense of humour	10. Always asking questions

IV Phy-maths. Teachers' Perception of the Creative Pupil

Table IV presents the rank order of the creative pupil characteristics which the Phy-maths. teachers and the experts on the creative personality consider most and least desirable. The most liked traits of 'Curious, Independent in judgment, and Independent in thinking' are common to both the groups. For the least valued, two characteristics chosen by these teachers agree with those chosen by the experts. They are : 'Timidity and Haughty and self-satisfied'. Most of the characteristics chosen as least valued by these teachers show non-conforming tendencies in the pupils, *e.g.*, 'Negativistic, Distrubs class organization and procedures, Always asking questions, likes to work alone, and Critical of others'.

TABLE 4

THE MOST AND LEAST VALUED TRAITS OF THE CREATIVE PUPIL AS PERCEIVED BY THE IN-SERVICE PHY-MATHS. TEACHERS

Most Valued Traits	*Least Valued Traits*
1. Curious	1. Stubborn
2. Independent in judgment	2. Negativistic
3. Self-confident	3. Disturbs class organization and procedures
4, Considerate of others	4. Timid
5. Healthy	5. Bashful
6. Industrious	6. Haughty and self-satisfied
7. Does work in Time	7. Talkative
8. Adventurous	8. Always asking questions
9. Obedient	9. Likes to work alone
10. Independent in thinking	10. Critical of others

Discussion

'Curious and Independent in thinking' as creative pupil traits are supported by the prospective, the in-service as well as by the Bio-chem and Phy-maths. teachers. These traits were also endorsed by the U.S A. educators (Torrance, 1965), elementary and secondary school teachers of the Germany (Torrance, 1965), the science teacher of the U K., and India (Wilkison, 1972 ; Raina, 1969 ; Pachaury, 1973), the urdu teachers (Pachaury and Sharma, 1978), the Naga teachers (Pachaury, 1981), and the Bhutiya elementary and secondary school teachers (Pachaury and Sharma, 1984b). Another characteristics 'Independent in judgment was supported by the in-service science teachers and also by the Bio-chem and Phy-maths. teachers of this sample. This trait was reported by other studies as well (Torrance, 1965 ; Pachaury, 1975 ; Pachaury and Sharma, 1978 ; Pachaury, 1982a). Yet another characteristic of 'Courageous in convictions' of the creative pupil was endorsed by the prospective, the in-service, and the Bio-chem teachers of this study. This trait was also endorsed by the 4-year humanities teachers (Pachaury, 1975). 'Always asking questions' as a creative pupil trait was supported by the urdu teachers (Pachaury and Sharma, 1978), the Naga elementary teachers (Pachaury 1981 ; 1982a), the Hmar elementary and middle school teachers and headmasters (Pachaury, 1982b), the Meitei elementary educators (Pachaury, 1982a), the Bhutiya and Nepali elementary teachers (Pachaury and Sharma, 1984b), the Nepali secondary teachers (Pachaury, and Sharma, 1984b), and the history of secondary teachers (Raina, 1982). The in-service, the Bio-chem. and the Phy-maths. teachers, infact have opted to punish or discourage this trait in their pupils. This trait is also not reported by the scientifically advanced countries of the U.K., and the Germany (Torrance, 1965) and Wilkinson, 1972). To the extent, science teachers of this sample, support three or four traits of the creative pupil, they compare well with their peers in the country and abroad. Teachers of Greece and the Philippines did not support any of the traits of the creative pupil as agreed upon by the experts on the creative personality (Torrance, 1965). For the development of the other creative traits in-service programmes should be organized, so as to acquaint these teachers with the views of the experts and educate them for the nurture of these traits in the science classrooms.

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Electronics and Computer Awareness of Education

—Some Issues

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AFTER THE second world war all the disciplines of science and technology have progressed with a rocketing speed. The scene of application of these new devices and principles was not only confined to war and peace fronts; earth, ocean and space; trade and industry; health and education but penetrated deep into our day to day life. Telephone and radio, cinema, television and VCR, besides computers continues to influence our life. The volume of knowledge is doubling in every decade. In view of this the Curriculum in educational institutions has been hanging for the better. For, a curriculum to be purposeful it has to be dynamic, need-based and should keep pace with time and society.

The Digital Electronics Revolution

Among all the disciplines of science and technology, probably of electronics, the growth has been one of the fastest. It is the one discipline which started its journey in 1920 with vacuum tubes and in 1971 within a span of half a century it reached "The Microprocessor" via the transistor and the micro-electronics.

Electronics has made very great impact and found greater acceptability than any other discipline by every one irrespective of the presence or absence of initial training or exposure to this field. That is why one finds around himself quite a large number of electronics gadgets to entertain him at home, and club, instruments to help him in his laboratory work and workplace. The quality of life whether it is an urban area or a rural area, has completely changed and continues to do so. These applications of electronics have created a lot of interest specially among the young school children which they have demonstrated by their active participation in science exhibitions, fairs. clubs and competitions at the national, state, district and local levels with most of their exhibits centering either around electronics or through electronics. Out of the many areas of electronics—communications, controls and computers are the most important ones. They are having a tremendous impact on society. Electronics has also started infiltrating into the office automation in the form of photocopiers, word processors, computing devices and electronic storage of data. The impact of micro-electronics has been to make electronics equipment, instruments and gadgets compacts and very cheap which had the needed impact on computer industry.

With the appearance of the microprocessor, a new class of computers i.e. microcomputer has found the market. The discovery of the microprocessor is compared with the invention of "The Wheel". The microcomputers are transforming the economy of industrialized nations the world over and increasingly affecting the jobs and lives of many people. The use of computers is extremely price-elastic in the sense that the cost declines and its use increases. Mr. G. Moore (Former Chairman Intel Corporation of USA) had predicted that the complexity of packaging components in an integrated circuit will be doubling every second year and we find that there is no going back on this account. Computing power is the only commodity which is falling in cost each year and personal computers will find their way in homes similar to digital watches. Later Mr. Robert Noyce (1977, Chairman Intel Corporation) summarized the practical consequences of Moore's law as : "Today's Micro computer at a cost of perhaps $300, has more computing capacity than the first large

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* The views and opinion expressed in this article are entirely personal and based on the understanding and thinking of the author.

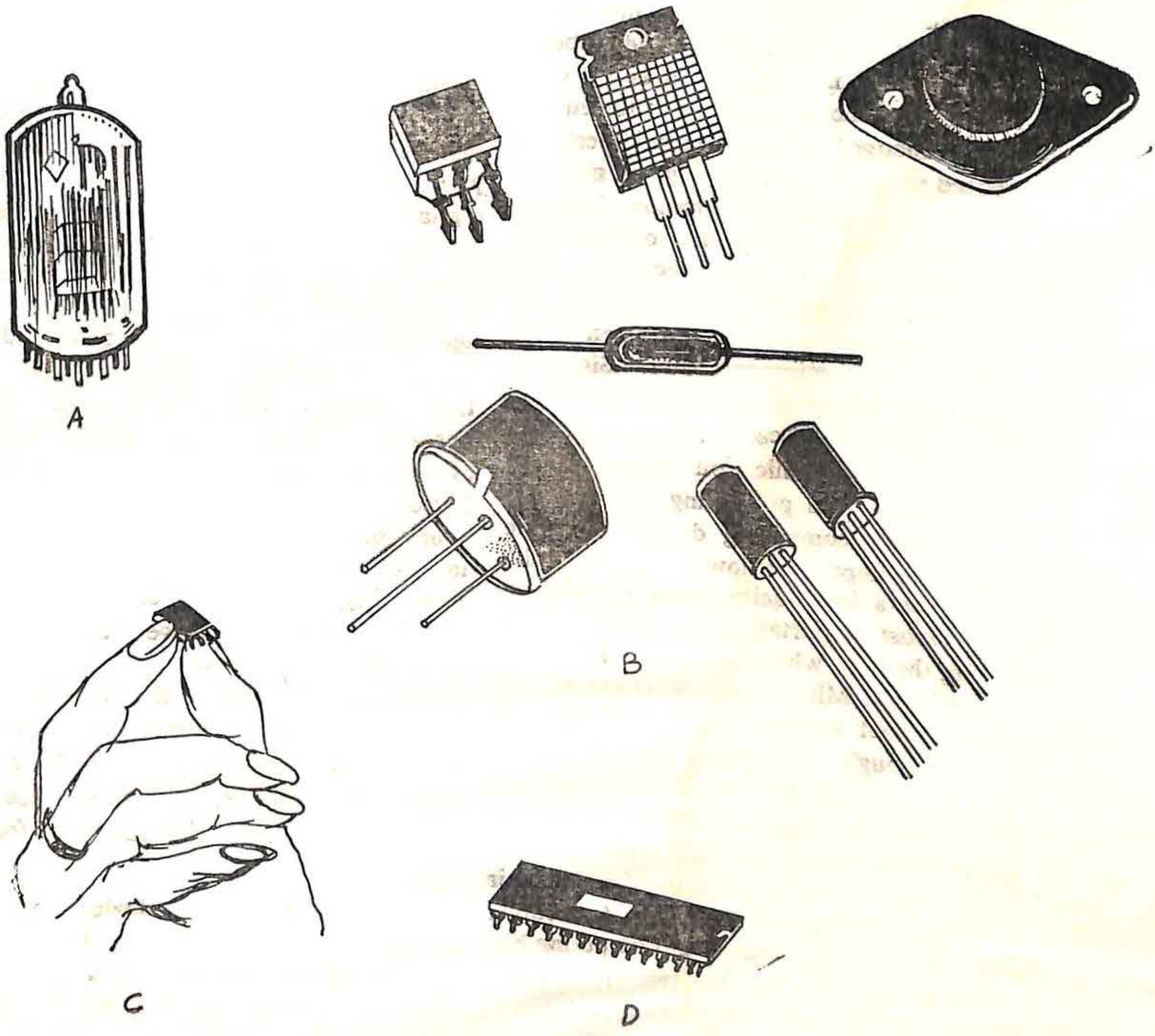

Fig. 1. Journey of active electronic devices (1920- 1971). A. Vacuum tabe. B. semi conductors diodes and transistors. C. Integrated circuit. D. Micro processor.

computer ENIAC. It is 20 times faster, has a larger memory, is thousand times more reliable, consumes the power of a light bulb rather than that of a locomotive, occupies 1/30,000 the volume and costs 1/10,000 as much".

Computer processors have now become so inexpensive that they are replacing mechanical components that perform measuring and controlling functions in a wide range of equipments starting from sewing machines, cooking oven to space-crafts and robots. Such replacement not only reduces the cost but also enables the functioning of the equipment to be changed via software modifications as opposed to expensive retooling. A modern communication and information holding systems are based on the electronic generation, transmission, storage, reception and utilization of digital information, hence all these could be very easily and efficiently be performed by microcomputer. Similarly combinations of processors, memories and input/output devices can be programmed to function as communication system, data processing or word processing systems. The introduction of computing devices in office will have an impact at lower cadre of white collar workers in reducing job opportunities but the most important impact would be in changing the way white collar workers will work and play. Micro-computers have started making impact on the playing habits of children through video games.

As the capabilities of these inexpensive microcomputers increase they are finding their place in modelling and stimulation of human senses. As a result of all their capabilities and many more are to follow. They are not only affecting computing but have started changing the style of our work and play along with the economy. Microcomputers and the devices they control are, therefore, going to have an increasing role in determining how we live. Micro-computer or "The New Wheel" is in effect bringing about the same type of revolution in the society as was witnessed when engineering got into business during the Industrial Revolution.

Relavance of Computer Awareness

In India, social, economic, technical and political factors had their say in the use and inclusion of computer for general education and these have slowed down the entry of computers in the scene. Of course, in scientific research, defence and engineering institutions they are used but not extensively. Now, having known the importance of this digital technology there is a change in the thinking of sociologists, technologists, educators and decision makers. We are drifting from the general atmosphere of "an age of Technology" to a specific goal of a "digital technology". We recognise education as an agent for social change. We also know that education is dynamic and the future of education can not be the same as its past. Since the social environment in which education functions is about to undergo massive change, that is, from an "Age of Technology" to an "Age of Digital Technology" induced by extensive technological substitution of the micro-computer. In the near future there will be a shift in the economy away from the industrial base towards an information processing. The Society will demand from the schools to produce workforce to participate in the new forms of work.

In dealing with technological systems we know that the output depends both on the system and on the input ; indeed, the two are to a large extent interchangeable. In many situations, the desired characteristics of the output are most easily achieved by preprocessing or influencing the input. The analogy may be directly extended to the educational system producing work force and socially useful citizen. The change in the output of the education system may be brought out by curriculum and extra-curricular experiences and the appropriate environments the students are exposed to. In the "age of technology" we had cared to include the subjects like science and *mathematics for all* in our secondary school curricula to provide them the technological awareness and to develop scientific temper. Although we are teaching basic ideas of sets, set intersection, introduction to binary representation, number systems use of number bases, flowcharting and diagram in our mathematics curricula, which are related to digital concepts but no direct exposure to "computer" has so far been attempted for them. It is still a 'magic' word. The children of today will work as an adult in the age of digital technology. It is therefore, obvious that unless an effort is made to take advantage of this boom of micro computers for training the future work force to be able to adopt to the new challanges to the new environment, they should continue their education and work, in the light of emerging technologies and disciplines as useful citizens. The delay in training the young children will continue to widen the already existing gap between the advanced countries of the world and developing countries like ours. Prof. Leihrmann of University of California has stated, "Computing plays a crucial 'role in every day life and in the national technological future that the general public's ignorance of this subject constitutes national crisis".

The ability to personally use computers is becoming more basic and requires the skills of every worker. As jobs become increasingly oriented towards computers, society demands and rewards individuals who know how to use these information processing systems. Automatic manufacturing bases its future upon a massmarket of computer-literate workers. Is our formal education doing its part to instill these attitudes ? We say No, not at present, but it has been recognized that we must tell our young friends the role, use and capability of computers. Secondly, computers can help to build the analytical and logical faculty of users. Computer can also enhance his capacity to manage and use information and so it is time we make an humble start. Hence we must make efforts to make "the New Wheel" the micro-computer available to our school children without delay and in line this the government has taken a decision to iatroduce computer Literacy/Awareness programme in the secondary schools at the level of last two years of public examinations. The project has been indentified as i.e. the Computer Literacy and studies in School (CLASS).

Micro Computer and Computer Literacy

What is Computer Literacy?

The dictionary meanings of the words "literacy" and "literate" are the "ability to read and write", and "able to read and write" respectively. This means "a literate" has moved from a situation of illiteracy to literacy and from a preliterate society to a literate society. We find that 'literacy' may be a function of three things : firstly, the role that literacy plays in a society and secondly, the way an individual comes to be more or less literate and thirdly, the environment he is living and working in

In India, we have already entered into an era of "communication for masses" through the commissioning of INSAT 1B, and installation of low power TV transmetres, they are providing television broadcasting to more than 70% of the population and would provide telephone facility within a radius of 5Km. by the end of this plan period i.e. 1980-85. It is imagined that future administrators managers, scientists, teachers, people and students will have an access to digital systems and devices controlled and operated by microprocessors. These devices would be as simple to use as they use public telephones by simply inserting a coin.

Computing power is the only commodity which is falling in cost each year and personal computers in homes will be just like digital watches as today that means we have to prepare our students for a "computerized society" (J. Hebenstreit 1981). Two types of computerized society have been imagined, they are :

(a) Professional type Society
(b) Service type Society

(*a*) *Professional Type Society*

Professionals and hobbyists imagine that in this kind of a society, each person would own a computer and use the same as he/she is using his/her typewriter and hand ools today to solve his/her private, personal and professional problems. They support the view of spreading computers to young people in schools by creating computer clubs, introducing computer studies in school curriculum and through professional society. They feel so because of their experience, sense of belongingness and to some extent because of their bias towards their hobby and profession. They regard computer as one of the greatest discovery and feel that every one must know about them. But the number of such people is very low and it may not be correct to conclude that majority of the people will go the way they think and wish.

(*b*) *Service Type Society*

In this it is imagined that every person has an access to computer and uses it as a set of resources and services to make his living simpler, to make things easier for him and perform his work with speed, accuracy and efficiency. But it is the specialists who will write programmes for these computers.

Looking into Indian situation we are inclined to agree to the view point that the "service type" of the computerized society is more likely to emerge in the near future. In this the user would become friendly to the computer and the "mystery" of computer would disappear and will make it a source of service similar to that of an electric iron, telephone, washing machine, radio and television. But for this the operation and mechanism of computers has to be simplified and the micro-computer of today satisfies these conditions.

Hence Micro Computer is an ideal device to implement the computer literacy and studies in schools.

Conclusions

In this age of electronics and computer, we ought to have a curriculum for school children at senior secondary level which should include basics of digital systems, awareness about information processing systems, the various types of mass media and their basic principles of working To have all these the existing curriculum of 'science for all' must include some components like 'electrical and electronics studies and activities' revolving around house wiring, domestic gadgets, identification of electrical and electronic components, basics of a public address amplifier system and principles of a computing system. The curriculum may stress upon the operation, up-keep and the utility of the above mentioned systems besides the content about them. The actual contents, methodology of instructions can be arrived at through a workshop of experts of various fields which may be drawn from the users, academic institutions, educational and training institutions and organizations besides the maintenance practitioners.

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On the Design of Learning Experience in Science Education

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AT THE very outset one has to answer three fundamental questions pertaining to learning experience :

(1) What to teach.
(2) When to teach.
(3) How to teach.

The first two are of curriculum design and latter is of teaching approach. Reforms in science education via these questions are being brought out constantly and continuously for the last two decades or so, but with not so pragmatic results. The exploration of learning experience is a major task which requires a unified effort on the part of science specialists, psychologists and the method masters. The situation should be carefully analysed, so as to generate interest and a favourable disposition among our students. Some tentative suggestions are listed in this direction in the subsequent paragraphs developed on the basis of framework. Presently our efforts are delimited to teaching of chemistry, especially at Higher Secondary stage of schooling.

What to teach implies course, content or concepts which has been under constant review for the last two decades or so. Earlier main emphasis was on the descriptive chemistry, but 60's saw a change in thinking shifting the emphasis on understanding and application of the basic principles/concepts. Science is experimental in nature so investigations found due place in the curriculum. Now changes are visible in developing need based science curriculum appropriate to particular environment. What will be the future trend ? Obviously there will be some modification. May be clinical chemistry, environmental chemistry or energy would find their place in the curriculum. In bringing about the change, there is a tendency of forgetting to include the relevant points in the previous existing curriculum. What is needed is a balanced approach which may be interplay between the empirical and the abstraction, rational association between present teaching and the real existing needs of our students. What is needed is proper amalgamation of descriptive chemistry, its basic principles, functional aspects of chemistry and experimentation. For example, if one speaks of the Chatelier's principle and explains it solely via displacement of equilibrium in some reaction, only a very filmsy and limited idea is conveyed. On the other hand the principle should be explained in its entirety as the expression of a great evoluationary phenomenon with reference to environmental conditions. This should indicate the sense in which chemical processes take place under varying circumstances.

The laboratory work should provide optimum opportunity for developing certain habits and ways of thinking to show that chemistry is both empirical and creative, and the thinking is both reflective and quantitative. The traditional practicals to just verify the laws and to determine physical properties should be modified to include besides above aspects a component of their applications to day-to-day life. For instance, the experimentation on surface tension should not merely be done just to determine the surface tension of an unknown liquid, but also to determine its role in regard to the cleaning action of various soaps and detergents available in the market. Modern trends in lab. work are warmly entertained and this change is really one of the strength of curriculum reforms in science. After deciding the nature of the curriculum, one of the vital points is to consider the quantum of the course. This quantum should be in conformity with the teaching strategy adopted. The syllabus should be tailored in accordance with the mechanism of teaching and the behavioural changes to be brought about. If we become too ambitions with regard to the quantum part and the communication part, we are running into a great risk. Neither proper comprehension of the concepts will occur, nor the strategy will become functional, because the objectives have to be obtained within a short specified span of time.

Coming to the second question, no matter how sophisticated a course is laid down, unless it is suited to the psychological needs of the students, our exercise would be futile. The course designed should be properly researched so that it is in tune with the cognitive domain of the learners. It is self evident that the capacity of human beings to process information and to solve problems changes with both age and experience. The effect of age, in relation to the young learners, is normally thought in terms of distinct levels of intellectual development (Piaget Model).

The intellectual level attained by an individual influences and delimits his ability to cope with particular concept. This is a particular facet which is especially relevent to the conduct of science education at the secondary school level. The implications of the Piaget model for chemical education have to be extensively explored, though there have been a number of research studies 1,2 abroad, but not in our country. This may give a base for educational decision making as what ideas can be grasped in a meaningful way by the pupils at different age levels.

The second facet when to teach is the experience. It may be interpreted according to Kempa as :

(1) The ideas and information previously encountered acquired by a learner.

(2) The extent of drilling which the learner has had in the use and application of this information

As regards the first point, if the learner is exposed to a particular concept or idea after he has learnt the underlying "lower level concept", he would be able to grasp it in effective and meaningful manner. For example, 'elements' should be first discussed and then the 'compounds' and not the other way round. This is what is called learning hierarchy according to Gagne, in which ideas or concepts are sequenced in such a way that they lead to higher order concepts in the most effective and logical way. The great advantage of this hierarchy is that it provides a correct sequencing of the subject matter in a curriculum, though it is not a simple job. Moreover if subject matter is taught with no reference to the previous knowledge of the students, there is a danger of break down in communication between the student and the teacher. White observes in this connection, to quote "If the teacher starts too high in the hierarchy by assuming his pupils know more than they do at best there will be a confused period while he tries to teach them something and fails possibily causing resentment and loss of motivation among his class...........in an extreme case, there could even be a complete break down in communication between the students and the teacher. If he starts too low, again there is a possibility of damage to the easy operation of the class room, and there will in any circumstance be loss of time through inefficient teaching". Sequenced subject matter should not pose problems of the above type and there is a great need to write our textbooks likewise.

After deciding what to teach and when to teach, the next important aspect of learning experience is the learning technique of the content course. By and large in our schools and colleges, lecture method is followed where the students are only the passive listeners. And they would forget all after sometime. If a better retention with understanding is aimed for, then the pupils should be exposed to the situation where they can use their more than one sensuary organs.

In one situation films, strips, 3 D models, bio-visual charts etc. would be used and in the other one, the pupils would learn by doing themselves. The first situation can be called an expository technique and the second one the discovery approach which is closely linked to the role of laboratory work. A large number of investigations had now been carried out and most of them report no significant differences between the two techniques, though the issue is yet to be authentically verified. However, it has been found that the discovery learning promotes the acquisition of discovery skills and is relatively more effective for low ability group students, whereas better retention is obtained by the expository technique. It is obvious that we should avoid teaching by lecture method and adopt the technique which would promote understanding among the students. This would develop in the pupils the right aptitude and attitude towards science. In every situation, it may not be practical to use one technique. Therefore, an approach should be adapted according to (*i*) the need of a particular batch of the students, (*ii*) the need of the course and (*iii*) the experimental facilities available. As mentioned in the beginning, the content course should be lessened (in comparison) to what we have today) in our schools or at least properly researched to suit the needs of the better learning techniques.

As regards with the learning of the key concepts, basic principles, especially conceptually difficult ones, both the techniques may be tried out. Firstly, the teacher will have to collect, in advance, the teaching aids like films, 3D models, charts, posters, transparencies to be shown to the pupils, and some of these may be made by the students themselves. Secondly, demonstrations may be performed related to the particular concept. Set of such teaching aids is called a Resource Box which should be handy. Spot studies to various places of interest in reference to a particular topic may be arranged too.

In the present day situation in common schools, little emphasis to learn in the laboratory is given. The poor performance of the students is due to the 'cook book chemistry' approach i.e. giving the specified procedure. A proper approach is needed where the students learn the practical skills and capability to apply the skills in various day-to-day life situation. Flexible approach to suit the need of a course should be adopted. For example, in the situation where the number of students are large and equipments are less, a group participation approach worked out by Wham may prove worthwhile.

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Evolution of Science

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SCIENCE IN our age has grown up into an institution giving employment to hundreds and thousands of men and women. However, this is a very recent phenomenon. Science has achieved an importance comparable to the far older professions only in the present century. Today, for many people not associated with its disciplines, science is an activity pursued by a set of people—the scientist. The word 'scientist'—itself is not very old. It was first used in 1840 to describe a cultivator of science in general.

The word 'science' is derived from the Latin word 'science' meaning knowledge. The term 'science' in its broadcast sense embraces all forms of systematised knowledge. Science in our age is understood as knowledge and cognisance of something specific However, to assign any specific definition to it will be an exercise in futility, for as Bernal has pointed out "science has so changed its nature over to the whole range of human history that no definition could be made to fit".

A similar view that has been expressed by the eminent scientist and philosopher Albert Einstein in following words "science is something existing and complete, the most-objective thing known to man. But, science in making, science as an end to be pursued, is as objective and phychologically conditioned as any branch of human endeavour so much so that the question 'what is the purpose and meaning of science' receives quite different answers at different times and from different sorts of people".

Science, more than any other human occupation, has continuously changed its contours and dimensions alongwith the onward march of civilization. Even a cursory glance at its history will show that science is not an entity to be amenable to any particular definition of any age. Science by its very nature does not climb on an ascending straight path, but moves—in a zig-zag fashion corresponding to the phase of rapid advancement and decline.

In the ancient period, science confined to the earliest mathematical and astronomical documents, was taught by priests and scribes in monasteries and temple schools. Science was not a subject on its own and constituted only a part of religious and philosophical doctrines. As a result, for a long time, science remained some what in different to the practical application of its conclusions. Also for a long time technology had to do without the help of science ; the trend of scientific revolution during the 'Renaissance' first took place in North Itlay, then in Germany, followed by England.

The development of modern science may be divided into four major periods. During the first, centred in Itlay, mechanics, anatomy and astronomy renewed and replaced the ancient doctrines of man and the world. During the second phase, science travelled to the low countries of France and Britain hammering out a new mathematical and mechanical interpretation of the world. Then, after a gap, the third phase occured in industrial Britain and France, struggling to shake off the yoke of feudalism. It opened to science new avenues of experience such as, electricity, which was untouched by the Greek. It was during this period that science had a decisive impart on power production, machinery, and chemicals, transforming the techniques of productions and means of transport. The fourth, and the greatest transformation is the scientific revolution of our own age. Science is now emerging on a global scale revolutionising the old concepts and creating new industries. Science is penetreting and permeating each and every aspect of human life. Now we also find science directly involved and decisively influencing both the horrifying drama of wars and the beneficial social revolution.

Now it is generally accepted that progress in science is quicker, safer and surer if it is pursued in the light of its past history. Any scientist who tends to overlook, undermine, or ignore the scientific and historical truth does it at the great risk of his professional competance and reputations.

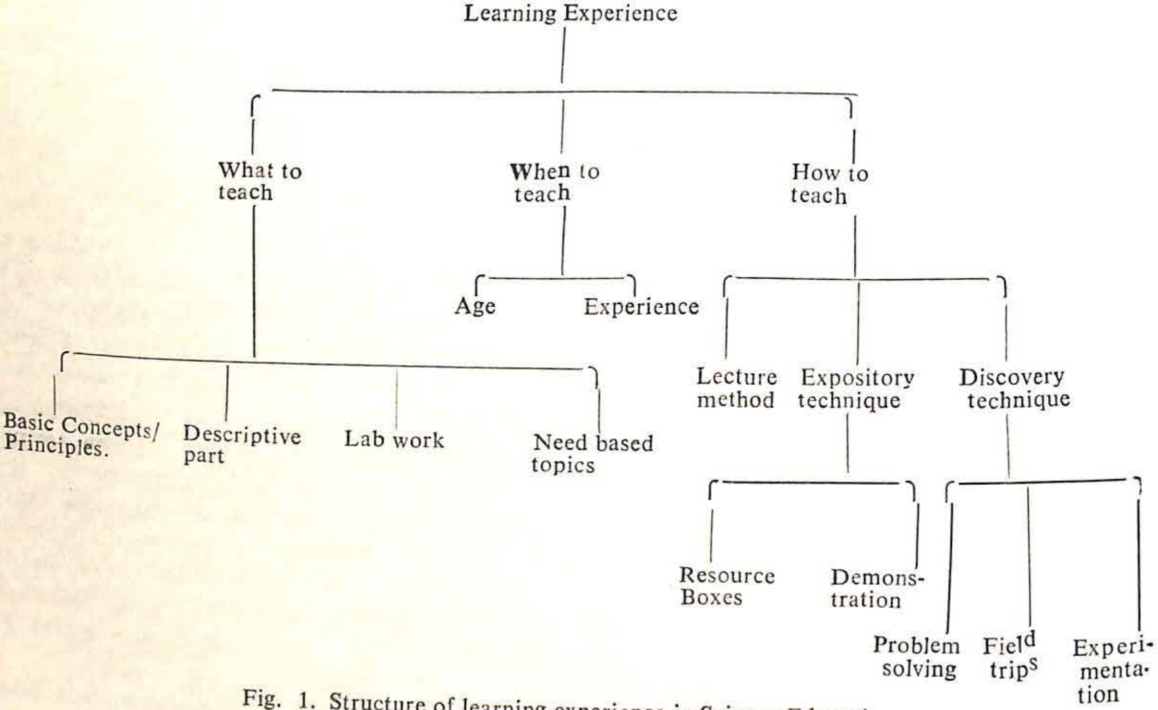

Fig. 1. Structure of learning experience in Science Education.

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Science News

Cure for a eye disease

A DRUG derived from the deadly bacteria that causes the food poisoning called botulism is helping people with a rare eye disease to keep their eyes open.

The Massachusetts Eye and Ear Infirmary in Boston is one of several medical centres testing the new drug on some of the estimated 150,000 Americans who suffer from "belpharospasm". The disease causes victims to close their eyes uncontrollably.

In many cases the disease is so severe that it prevents sufferers from reading, driving a car and even watching television. It mostly strikes women older than 50 and is believed to be caused by abnormalities of the brain areas controlling motor function.

Smoking—a reproductive hazard

SMOKING AS a habit is "a reproductive hazard" for women, not just that those who smoke in pregnancy pose health risks to the foetus, a new study here shows.

It has now been found that cigarette smoking impairs fertility in women and it takes them longer to become pregnant when they try to conceive. Heavy smokers have greater difficulty conceiving than light smokers.

The study, published in the journal of the American Medical Association has not determined what causes impairment of the reproductive capacity of smoking women, but suggested it could range from a temporary, localized disruption of uterine function to mutagenic damage of the egg.

The new results stem from a survey of pregnant women specifically designed to probing the relationship between smoking and fertility.

In the past, researchers have sought to establish that smoking by women increases the chance of spontaneous abortion, low birth weight, and death of baby soon after birth. This study and other laboratory findings are now offered as evidence that cigarette smoking is a reproductive hazard even before women know they are pregnant.

But smoking habits of the husbands have no measurable effect on the fertility of their partners, the study concludes.

The danger of marijuana

TWO STUDIES show that marijuana may damage the human reproductive system, perhaps even in the offspring of pregnant women who smoke marijuana.

"Smoking marijuana during pregnancy might cause irreversible damage to those cells in the (foetal) brain which control the female glands", said Dr. Amarendra Kumar of Boston's Tutts University School of Medicine.

Dr. Kumar and his colleagues gave newborn female rats the equivalent of two to 20 marijuana cigarettes worth of trahydropcannabinol, or THC—marijuana's active ingredient—during each of their first five days of life,

The rats never developed normal female cycles, indicating permanent damage. And when the rats were killed at 10 months of age, they were found to have abnormally low levels of a chemical necessary to trigger the brain's pituatary glands to help make ovaries produce eggs.

225 million old dinosaur fossil found

SCIENTISTS SAID today they had found dinosaur skeletons at least 225 million years old in dry Arizona Wasteland which may be the oldest dinosaur ones ever discovered.

Scientists said the dinosaur—tentatively classified as a plateosaur, may be from a family of previously undiscovered reptile. It would be a predecessor of the mightly brontosaurs.

The bones of a creature about the size of a small ostrich weighting approximately 200 pounds are expected to be flown within the next few weeks to the University of California at Berkeley to be studied.

The bones were discovered in the petrified forest National Park of Arizona by a team led by UC—Berkeley Palaeontologist, Dr. Robert Long. Dr. Long who has been studying the Park's "painted desert" for 20 years said two skeletons were found embedded in slab of rock.

According to a university spokesman, a remarkably complete leg of one skeleton already has been recovered along with some ribs and vertebrae.

Fossils of giant lizards

FOSSILLIZED BONES unearthed by geologists working in Northern Queensland show that giant lizards and huge horned tortoises once roamed Austrialia.

Greg McNamara of James Cook University, said the site, a stretch of great Barrier Reef shoreline at Greenvale 1728 km. northwest of here, had been worked for the past two years. It was only recently that McNamara realized what the finds were.

McNamara estimated the age of the site at between 400,000 and three million years. He said the most exciting discovery was that of a giant goanna the largest known lizard to have ever lived. He said the goanna was about twice the size of the Komodo dragon in Indonesia, which at 3.5 m in length is the largest living lizard.

The Komodo dragon, normally a carrion feeder is known to attack and devour livestock. At twice the length of the dragon it would have been some eight times as massive and would have had a correspondingly voracious appetite.

The team also found remains of a gigantic, horned tortoise, similar to depostis found on Lord Howe island off the east coast of Australia,. However, the Greenvale tortoise "far surpasses" its size. Other remains unearthed include an extinct specied of wallaby and bits of crocodile.

Pregnancy from frozen human embryo

AUSTRALIA'S LEADING in-vitro fertilization (IVF) group has reported the world's first pregnancy from a frozen human embryo.

Dr. Alan Trounson, scientific director of the Epworth Hospital Monahs University Infertility Unit has said that a childless Victorian woman was in her 14th week of pregnancy after being implanted with an embryo that had been frozen for four months.

All indications—includin g two ultrasound examinations—were that the baby was developing normally.

Dr. Trounson and research scientist Ms Linda Mohr have worked on the human embryo-freezing technique for three years.

The wife was infertile because both fallopian tubes were locked. Doctors used IVF techniques (already responsible for 100 pregnancies in Australia) to collect four eggs in 1982. After fertilization, three were reimplanted two days later. The fourth was frozen a few days after collection. The couple requested implantation of the frozen embryo four months after the original collection.

Mummies of northern philippines

A LARGE number of ingenously preserved bodies were left behind by ancient Ibaloi and Kankana-Ey tribesmen in the Cordillera mountains of the Northern Phillipines. Experts believe they may be the only mummies outside Egypt and Central and South America.

Nobody knows exactly how old they are and experts only have theories on how they were preserved. Modern Christian tribesmen bury their dead like their brothers in the lowlands and the mummy process is virtually forgotten.

The corpses have endured the ravages of time while stored in dry and cool caves on the steep sides of mountains Access to the ancient burial grounds is now forbidden by natives who still worship ancestors as gods.

Mr. Gabriel Pawid Keith, an authority on mummies in nearby Benguest province, where most of the caves are found, wrote that this could be due to the desercration of some corpses after three such caves were opened in the 1960s.

The tendency of the people there now is to be secretive. They do not want to show the caves to people, a top tourism official in this city, the nerve centre of the heavy tourist traffic in the Cordillers.

Local experts theorize that mummification was limited to the richer tribal families in mourning rituals that took from two months to a year. Mr. Andaya, however, said it was possible that the practice "might have been accidental. They might not have been aware that the process led to mummification" which could explain why they no longer practise it.

Mr. Orland Abinon, chief of a Nationa Museum Laboratory section that took over mummy section research in 1982 said in Manila that an Ibaloi nobleman about to die was stripped naked, tied to a chair and made to drink a salt solution.

Mr. Keith, who wrote a book on the practice, said the solution prevented the notting of the internal organs. The corpse was bathed in juices of medicinal herbs and a "death blanket" covered the corpse to absorb body fluids.

After a week, the entire outer skin was peeled off by relatives and the body was washed with cold water. Then the corpse was cleaned of worms, after which it was again bathed in herb juices until the body totally dry.

A small fire was build below the death chair to smoke the corpse untill it shrank. The body was then tied to the chair in a crouched position placed in the sun during the day and smoked at night. Mr. Andaya said the process included a continuous feast for the mourners.

Unlike the fully-bandaged specimen from the Egvptian sarcophagi the whitish mummies of Benguet are in a sitting position, with the appendages and vital parts dry and shrivelled but still intact. Some have intricate tattooes all over the body.

Mr. Abinon said the country has no carbon dating facilities to establish the exact age of the relics but experts estimate them to be from 200 to 500 years old. He said he had heard stories that some of the mummies were smuggled out of the country in crates after being bought at prices ranging from $ 500 to 1,000 a piece and that one such mummy was in a museum in Hawai.

Induced sleep in wild animals

TWO WILDLIFE experts have discovered that a slight pres ure around the ear induces sleep in wild animals. Mr. Raza Tehsin of the Bombay Natural History Society and Mr. J.S. Nathwat wildlife warden at the Kumbhal Gadh Wildlife Sanctuary in Rajasthan say this "anatomical weakness" has been exploited by small predators in over powering heavier animals.

From experiments conducted on various mamals they inferred that some superficial nerve passing near or around the ear region may be responsinle for this behaviour of the animals. A slight pressure on the nerve may stimulate the sleeping centre of the brain inducing sleep in the animals.

Mr. Tehsin and Mr. Natwa claim that if the cause of the sleeping inducing phenomenon is found it may reveal several mysteries of the human brain and help minimize human and animal suffering.

The first indication of the interesting phenomenon came to the two wildlife experts from some tribals in Kumbhal Gandh livestock-thieves who knew the mechanism with which they put animals in a trance. They placed a weight on the ear of the animal which immediately became inactive.

Further experiments by the two scientists showed that when a predator close its jaws on the throat of its prey the pressure produced by its teeth around the ear region produced instant sleep in the hapless animal.

The experts say further study in this direction may be of immense help to naturalists, veterinarians and allopathic practitioners.

No asthma link with parthenium

THE MUCH-MALIGNED "Congress grass" or carrot grass-parthenium wood may not be the cause of asthma, as is commonly believed, but it does cause allergic rhinitis in a large number of people.

A study conducted by the Indian Institute of Science found that 20% of a random sample of 2,000 people, however, had nasal problems. Most of them had rhinitis characterized by repeated sneezing watering eyes and running of blocked nose.

Professor P.V. Subba Rao, who lead the research team, said that 5.8% of the people were allergic to parthenium and 4.6% to dust. In all 9·1% of the respondents were found to be sensitive to parthenium pollen. This meant that 3.3% of them who did not show any symptom were either prone to developing nasal allergy or had developed immunity to it.

The survey confirmed that connecting parthenium pollen to bronchial asthma was "unscientific" and some regions which has an extensive growth of parthenium, was not an asthmaendemic area.

Many patients of bronchial asthma were allergic to house dust but none of the asthmatics who had no concurrent symptoms to nasal allergy were found sensitive to parthenium pollen. The scientist explained that this was because unlike other pollens, parthenium pollen grains were large and unlikely to go beyond the nasal passage and reach the bronchial tract.

Prof. Subba Rao said research was bein undertaken at Indian Institute of Science, Bangalore, to develope a vaccine for the specific sensitization of parthnium rhinitis patients through immunotherapy.

Parthenium, a South American weed believed to have entered India with the American wheat strain PL 480 is highly toxic to dairy animals and is also the cause the skin allergy. The weed has luxurient growth and flowers between June and September.

Eucalyptus unsuitable for arid zone

A STUDY on the impact of the eucalyptus on ecology has warned that if the large scale plantation of the tree in India's arid zones does not stop immediately, vast areas will turn into deserts and spread across the subcontinent. Eucalyptus forests in arid zones areas with an annual rainfall between 700 mm and 1250 mm per year dry up all available sources of surface and underground water, poison the soil and kill the fertility of the land, the study revealed.

According to Vandana Shiva and J. Bandopadhyaya, authors of the study of the massive afforestation drive continues entire stretches of farmland will become deserts of shifting sand and famines will ravage the country.

Food crops cannot be cultivated where eucalyptus forests grow because seeds do not germinate there because the trees exude toxic chemicals which poison the land and kill all forms of vegetation in their vicinity, according to the study.

Eucalyptus, which does not grow well in areas with rainfall above 1250 mm per year as it contracts a disease there is planted with best results in arid zones which have been marked by Forestry Departments as a "preferred zone", the study says.

Due to some destructive qualities unique to eucalyptus, the preferred zone's soil cannot support the tree on surface water. The tree starts drawing on under ground resources, though its roots do not dig deep. They spread laterally with invariably disastrous results-drying up all available moisture in its vicinity.

In arid zones where under ground water can be recharged only with percolation of rain water the tree sucks up the water on the surface disallowing water to percolate, drying up wells. This is one reason why eucalyptus forests do not have a by undergrowth the study says.

The tree exudes toxic chemicals and kills vegetation nearby with almost total success in a process agricultural scientists call allelopathy. This also disrupts the nutrient cycle of the soil.

The tree takes too much nutrition from the soil for its fast growth but gives hardly any leaf litter in return, the important soil enriching material. The nitrogen trapped in leaves is released by micro-organisms and earthworms who decompose the leaves molecule by molecule.

Very little litter in itself is bad but whatever drops on the soil exudes toxic chemicals, especially disliked by the nitrogen fixing organisms. They do not decompose the leaves and the nutrition remains trapped in them. But if the leaves remain unused on the soil for a long time their toxicity will kill the soil fertility beyond retrieval, the study says.

The chemicals inhibit seed germination and destroy all vegetation nearby. The University of Agricultural Science, Bangalore, in a study on the toxicity of the leaves, said they will inhibit seed germination of crop plants. No crop can be grown successfully near eucalyptus trees in low rainfall areas where there is every chance of the toxic substances remaining in the soil for a long time.

Citing the arid districts of Karnataka, where farmers call it "cisha vriksha" (poison tree), the study says the price of the staple food of the farmers there, millet and ragi has risen 200% in just two years as a result of eucalyptus plantations devouring farm lands at an increasing rate.

The authors of the ecological study quote numerous scientific and ecological studies and allege that the afforestation drive continues with unflagging enthusiasm are superior indigenous alternatives to eucalyptus like pongomia and tamarind.

These multi-purpose trees give fuelwood, wood for furniture, fooder, fruits and seeds for oil and support agro-based industries besides enriching soil fertility.

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The articles sent for publication should be exclusive to this journal.

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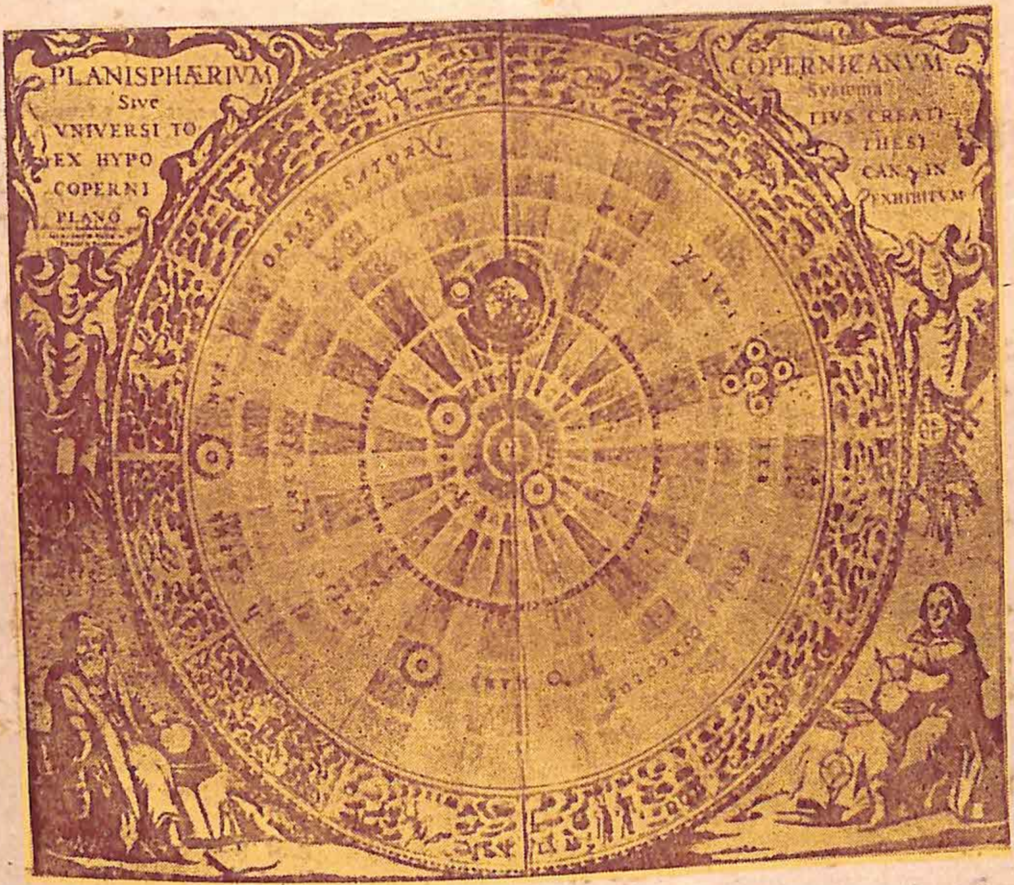

A 17TH CENTURY ATLAS USED THIS ENGRAVING TO ILLUSTRATE THE SUN-C ENTERED ASTRONOMICAL THEORIES OF COPERNICUS

Nikolaus Copernicus, a Polish Clergyman, was a student of law and medicine, though he had a keen interest in astronomy. In the days of Nicolaus Copernicus, the Earth was considered to be fixed and static at the centre of the universe, and the Sun and Planets circulated around the Earth. Copernicus never really accepted this theory—known as Ptolemaic System ; named after the Greek- Egyptian mathematician and astronomer—Ptolemy.

After completing his education, Copernicus went back to Poland and settled there for a career ; but he continued his search for a new theory on the heavenly bodies ; though, Copernicus, or any other person those days, had no telescope. By the year 1530, Copernicus, came forward with his new theory. In a manuscript form, he circulated this among interested astronomers of his days. The Pope encouraged his work, and finally, after a great deal of persuation, Copernicus sent his theory for printing in Germany. Copernicus died in 1543, soon after he received first copy of his book.

The book that Copernicus left to the world was titled **DE REVOLUTIONS ORBIUM COELESTIUM—CONCERNING THE REVOLUTION OF THE HEAVENLY BODIES**. Copernicus, proved that the Sun was at the centre of the Universe, with Earth and other Planets circulating around it ; and the Earth was not fixed but it turned on its axis. This discovery was known as *Helio-centric System.*

In the field of astronomy, the Helio-centric system led to the revolution in terms of new findings and theories for better understanding of the nature and natural phenomena. The discoveries of Tycho Bhane, Kepler, Galeleo and Newton, further elaborated upon the Copernicus theory and thereby laid the foundations of Modern Science.

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